

POPULAR SCIENCE

MONTHLY

MECHANICS - AUTOS - HOMEBUILDING



Ford Show Car Tests
50 Ideas - PAGE 122

25¢ October



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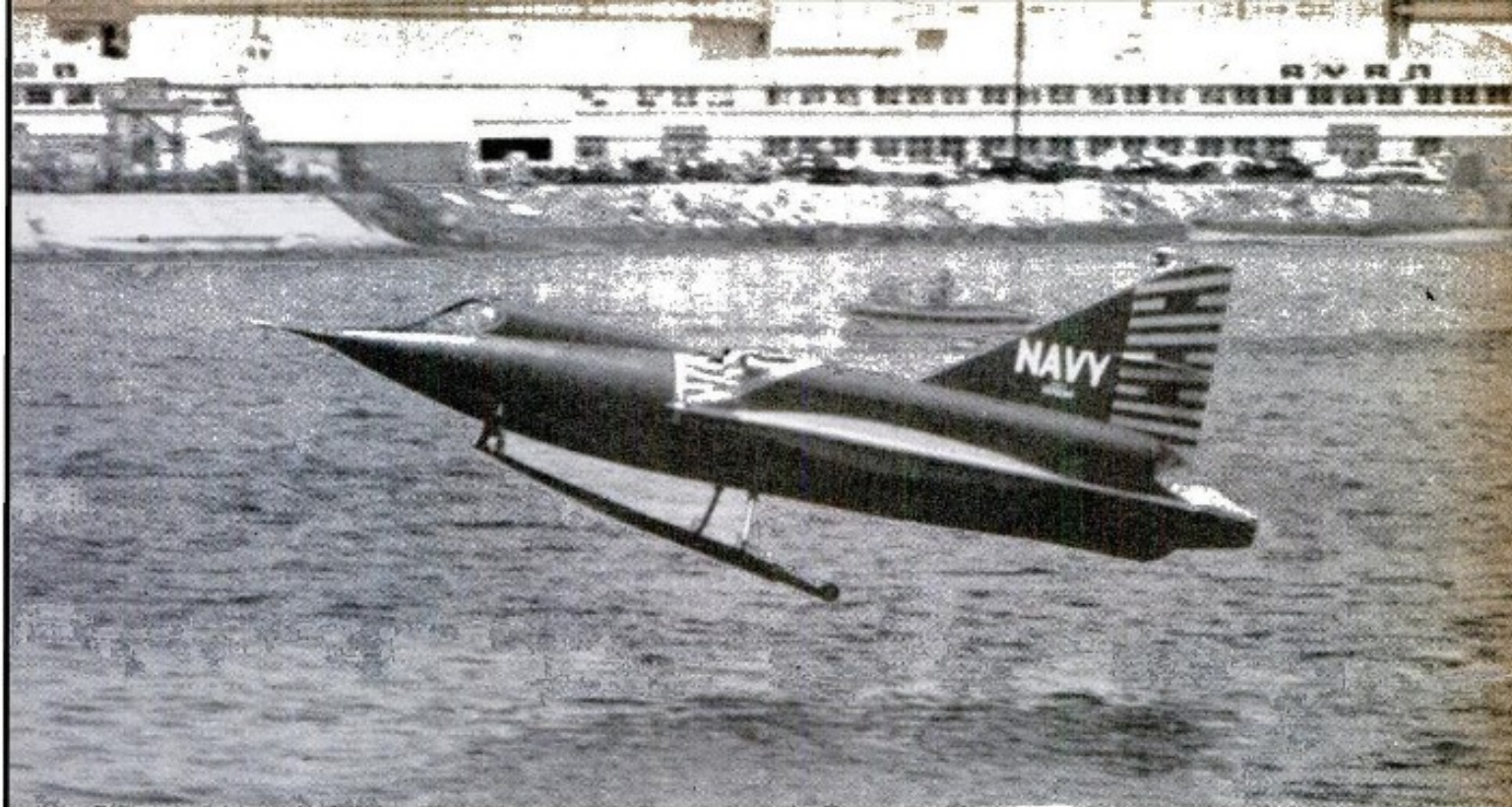
California's Cure for Traffic

Fireplaces Anyone Can Install

PAGE 155

All About
1954
Hudson





Navy's New Sea-Dart Takes Off Like a Flying Fish

THE Navy's ski plane, the delta-winged Sea-Dart (PSM, Feb. '53, p. 107), has taken to the air in test flights at San Diego, Calif. As shown at left, the skis fold up into the fuselage in flight. Neither the Navy nor Convair, the builder, is saying how fast the Sea-Dart flies, but she was designed for supersonic speeds. The interceptor is powered by two jet engines.



▶▶▶ Learning to breathe like a frog is allowing some polio patients to escape from their iron lungs for as much as 14 hours. The trick is to use the tongue as a pump to gulp mouthfuls of air into the lungs.

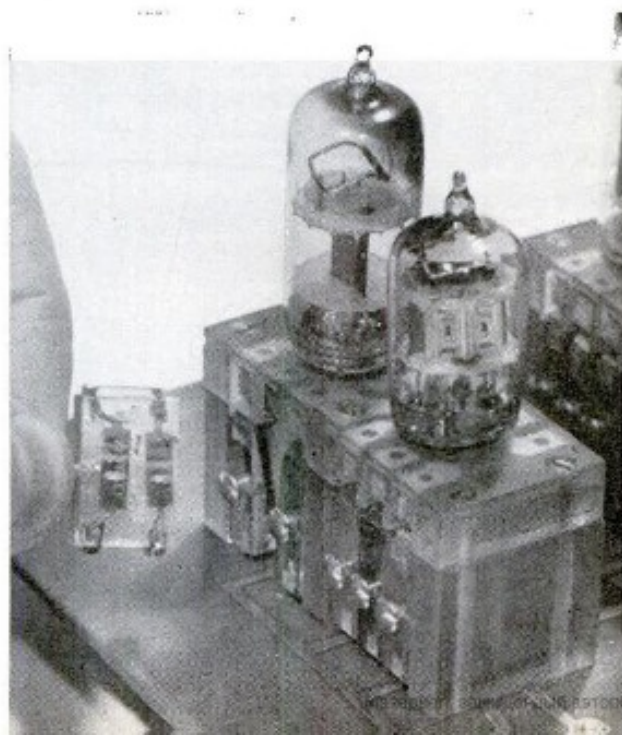
Block Circuits Have No Wires

ASSEMBLED like a building toy, the Bureau of Standards electronic equipment below has its circuit elements molded into plastic blocks with protruding contacts. These are spring-clipped between a circuit-etched base and a plate with tube sockets.



Outboard Rides on Two Hulls

LIKE a South Seas catamaran, this speedy craft has Siamese-twin hulls—but she's pushed along by an outboard motor rather than the traditional sail. Built in Miami, the boat's called a Catacraft.



California's Two Big Cities Ponder

Subways in the Sky

ONE day during World War II, while chauffeuring a B-29 bomber on a mission from Tinian Island in the Pacific, a San Francisco financier named George D. Roberts fell to thinking of problems back home. Suddenly he got an idea. As a result, Californians may one of these days be riding subways in the sky instead of bucking automobile traffic that's getting well-nigh impossible.

Single-rail railways, called monorails, rocketing along at 70 miles an hour on great pedestals high above the ground, are his answer to street and high-



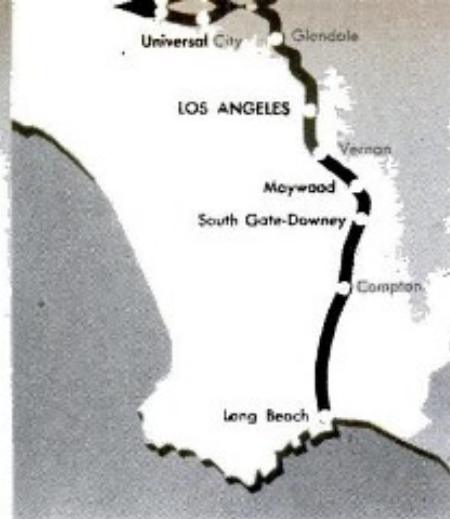


Continued on next page.

OCTOBER 1953 169



PROPOSED PLAN would operate monorail system in part over bed of Los Angeles River, link Van Nuys with L. A., Long Beach.



BAY AREA NETWORK would connect San Francisco with Oakland and San Leandro, extend south to San Jose, north to San Rafael.

way congestion around our big cities.

San Francisco may get the first monorail system. Its transit commission is studying the problem. The Los Angeles Transit Authority is considering the construction of a 42-mile line from the San Fernando Valley through Los Angeles to Long Beach down on the ocean.

The San Francisco plan proposes three major lines radiating from an underground turn-around station in the city's heart. Already, schedules have been calculated. Today the eight-mile trip from San Francisco's Civic Center to downtown Oakland takes 30 minutes by inter-urban and street car, 40 to 45 minutes by

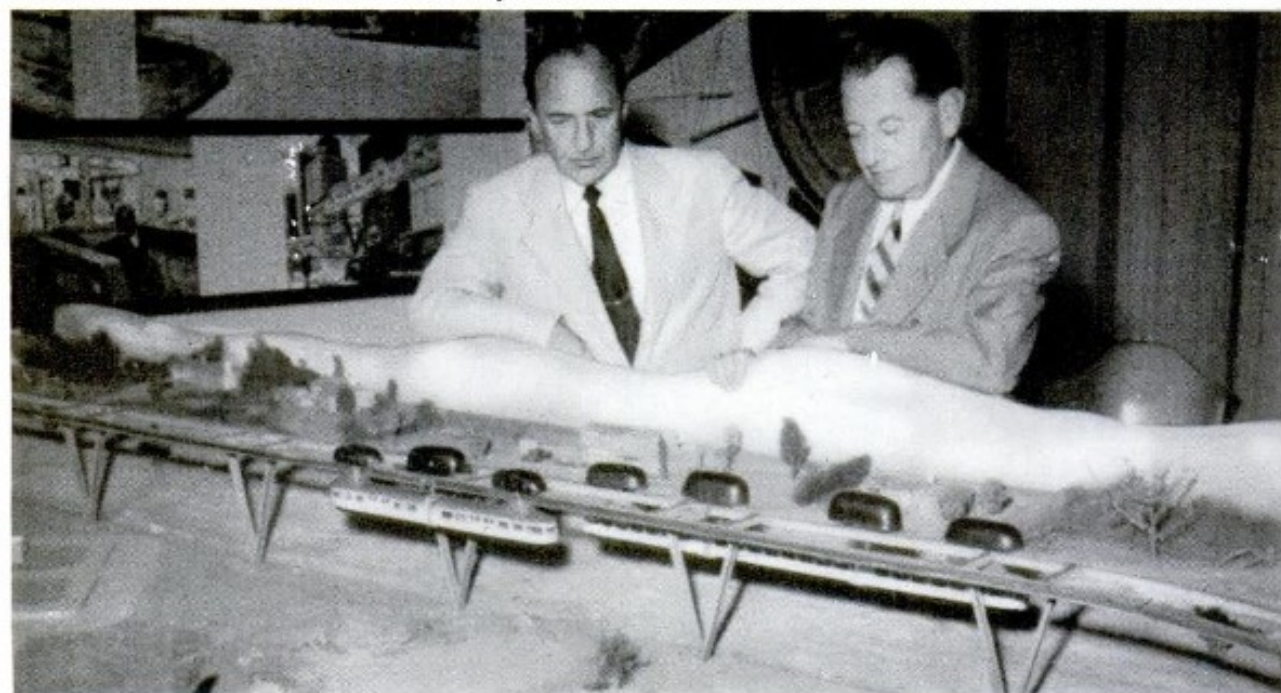
automobile. The monorail would do it in 12 minutes, with three stops.

Head of a company sparking interest in overhead transit linking cities and suburbs, Roberts says monorail trains would require a strip of earth only 56 inches wide. A single line of supporting columns would carry trains coming and going. Monorails could run above double-track surface railroads. They could run above the separation strips of divided highways.

Their cost would be a fraction of that spent on subways. And they could be built fast. Roberts says trains could roll in two years after the work began.

PROMOTER GEORGE ROBERTS (right) and an associate, J. U. Lademan, watch model air-conditioned monorail trains whiz by. Alumi-

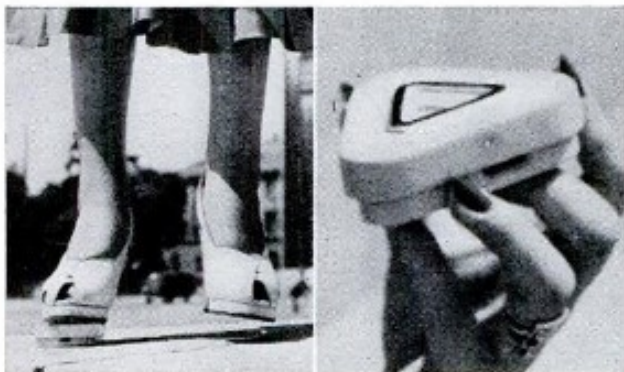
num cars would carry 60 seated passengers, 40 standees. Designed with picture windows, cars would ride on inflated rubber tires.





The Generals Ride a Mouse

THIS is Britain's newest army baby—the Field Mouse. A scout car with four-wheel drive, it made its debut at a combat-vehicle show for officers from NATO countries.



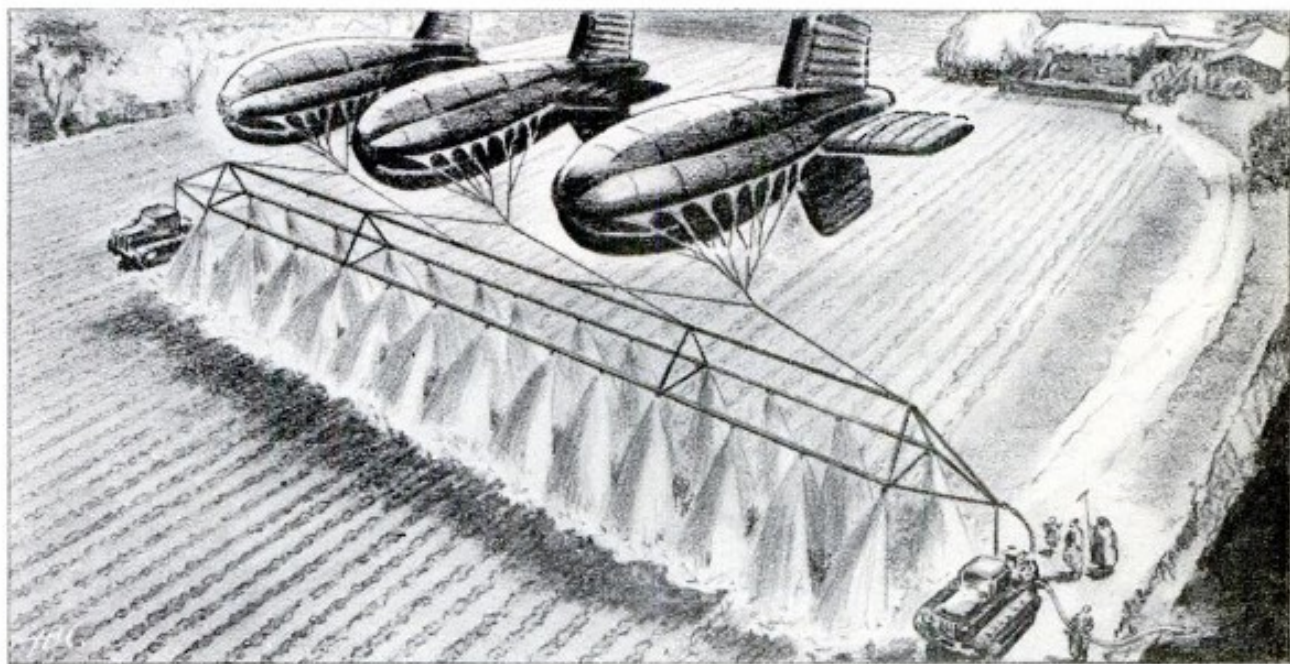
Scale Keeps Weight Secret

FIRST you step on the German scale above, then pick it up and read your weight in privacy through a lens in the side. The dial is then rezeroed for the next user.



Hobby Tunnels House

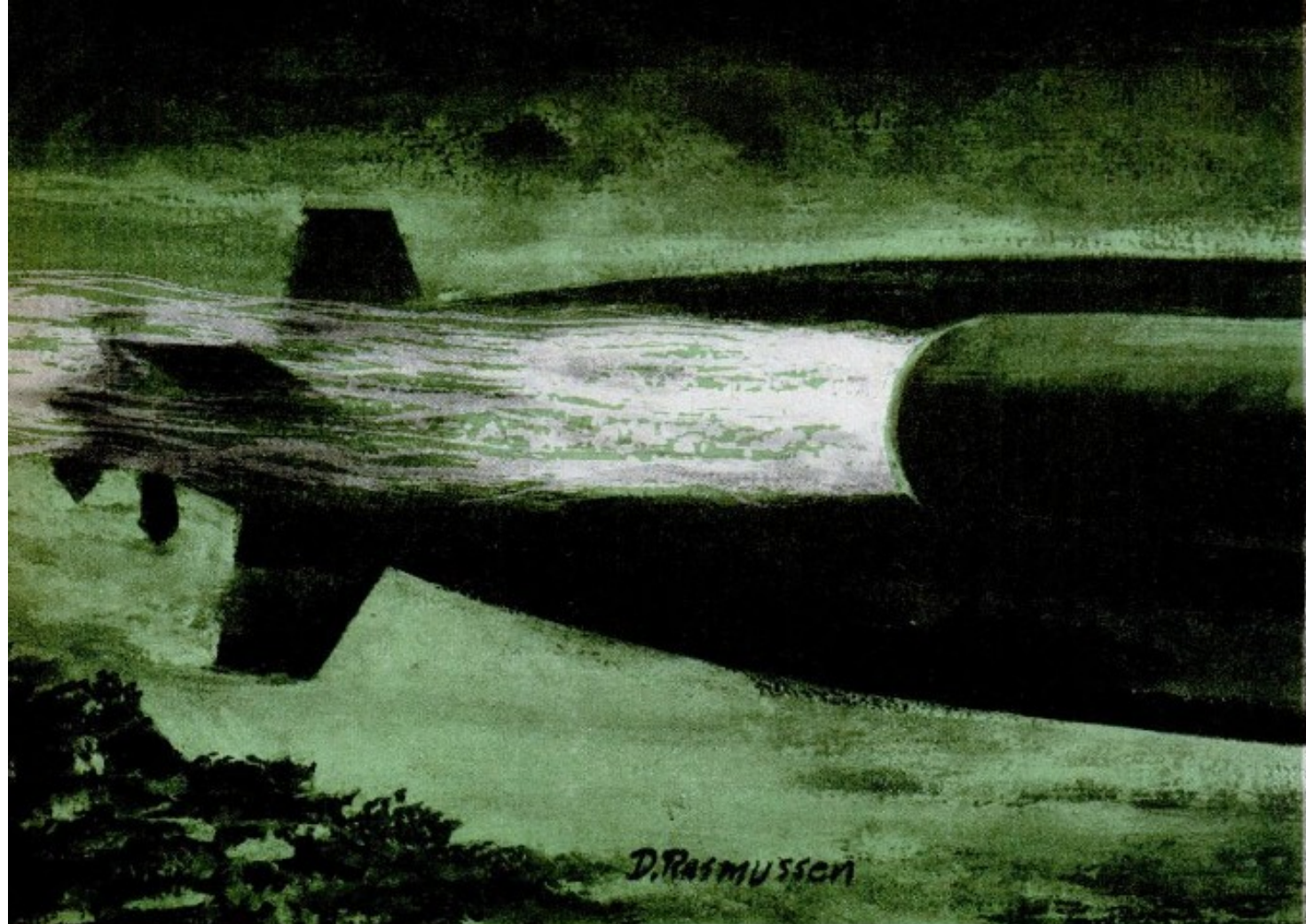
A PARIS watchmaker built this midget train of French rolling stock. And ran the line right through his basement wall out into the garden.



New Rainmaker Proposed—The Flying Watering Can

HUNGARIAN propagandists say their country is planning to irrigate farms alongside canals with sprinklers hung from barrage balloons. Fed by tractor-borne pumps, the

sprinkler would wet down fields 500 yards wide. Flexible pipe linking sprinkler and pumps would allow the balloons to lift the rainmaker over trees.



Silent Sea Engine

A magnetic pump with no moving parts, this simple device may propel our submarines silently along the ocean floor

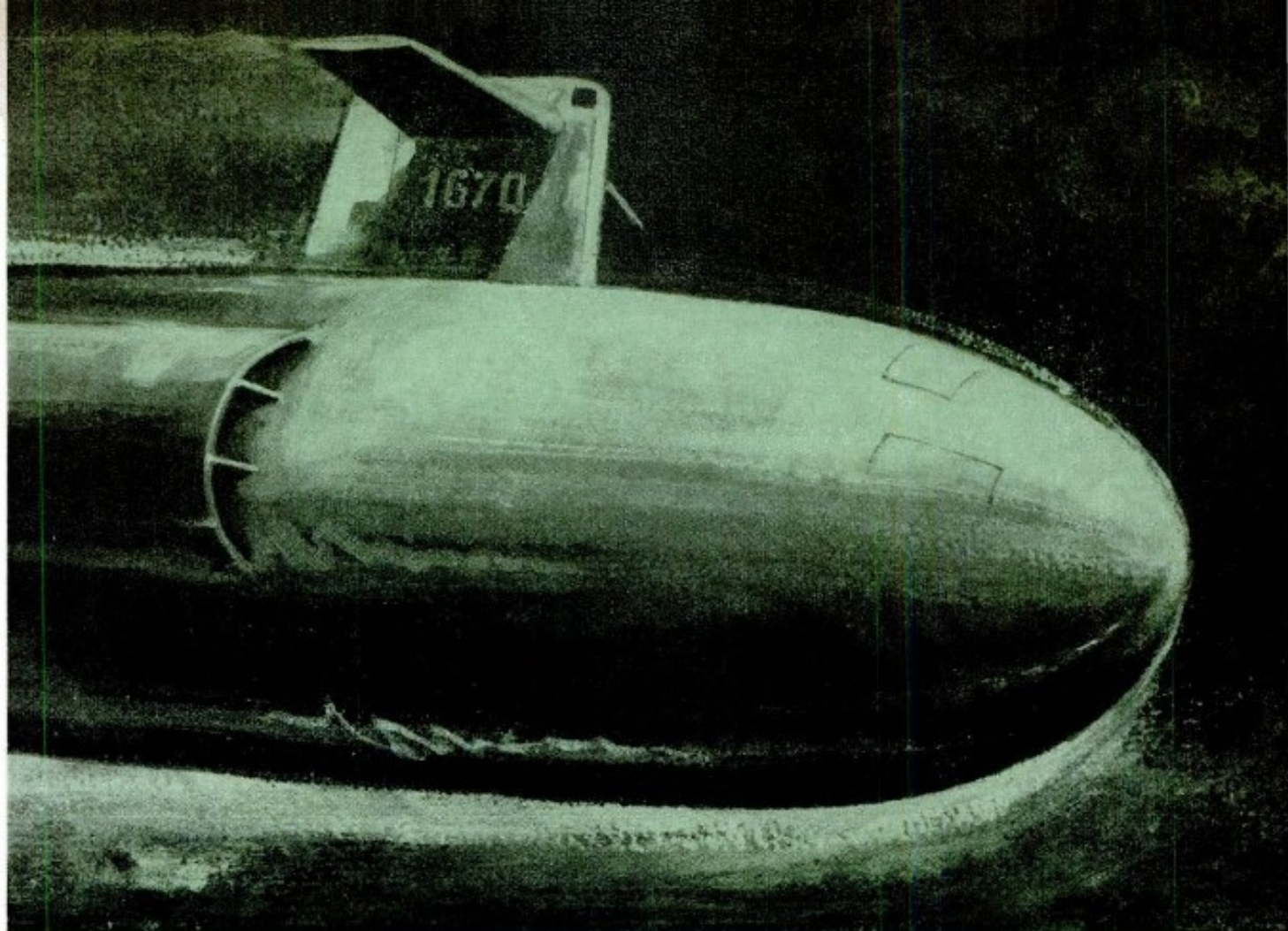
By JAMES G. BUSSE



First experimental model of the sea engine is demonstrated by biomedical engineer Sujoy K. Guha.

In the silent world of underwater warfare, the slightest noise can bring sudden death to a submarine. The electronic ears of the enemy can detect conventional engines and screw propellers as far as 100 miles away. A computer interprets the sounds and directs a deadly homing torpedo to their source in minutes. How do you go about maneuvering a 3,260-ton nuclear submarine without making a sound? Two medical researchers at St. Louis University's School of Medicine may have found the answer—a revolutionary undersea propulsion unit dubbed the "sea engine."

The interesting phenomenon upon which the sea engine is based was first observed in 1964 by Alfred W. Richardson, a physiologist, and Sujoy K. Guha, a young biomedical engineer from India. The two men were looking for a method of simulating the flow of blood through the human body. They tried



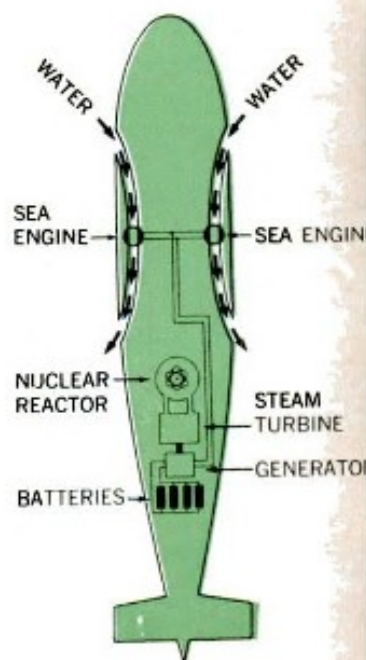
for Nuclear Subs

various types of mechanical pumps without success. The pumping action was too irregular.

While investigating the effects of magnetic fields on weak salt solutions similar to blood, the two researchers stumbled across an interesting fact: They could make the electrically charged atoms in such solutions move in one direction by applying a magnetic field in just the right way. Then they made a second important discovery: The moving atoms dragged water molecules along with them so that the entire solution moved.

Richardson and Guha suddenly realized that they had the makings of a new type of pump. They quickly assembled an experimental model and found, as they had expected, that the device really worked. Their "pump" consisted of nothing more than an unimpressive collection of junk-box electronic components. Yet the instant they connected it to a source of electrical power, a weak salt solution inside it began to move. A number of tests were made and new models were constructed, some of which permitted very accurate control over the quantity of liquid being pumped, and others which made the liquid move in a series of pulses, duplicating the pumping action of the human heart. Amazingly, the pumps could move a variety of liquids—including ordinary tap water—without difficulty. Then a visiting scientist from the Office of Naval Research suggested

Continued



Two electric sea engines could propel sub forward, backward, or turn it by pumping oppositely.



Army Jeep turns to skyriding. This new "Flying Jeep" will take off and land vertically, fly forward at 150 m.p.h. It is propelled by two rotors—one in front, one behind. It was developed as the 59K VTOL by Piasecki Aircraft Corp. for the Army as a high-utility, general-purpose

Picture News

IN THE WORLD OF SCIENCE



vehicle. Designed for extreme low flying, it hugs the ground, will fly under bridges or telegraph wires and behind low objects for concealment. With no wings to interfere, it will go down narrow streets, between buildings and trees. Dual engines, rotors and controls are in its flat body.

MAY 1958 III

Thrilling \$4⁹⁵ Book Digest "ADVENTURES OF
SECRET SERVICE"

POPULAR SCIENCE

AUGUST • 35¢ Monthly

Gas Flame
Lifts New

Hot-Air
Balloon

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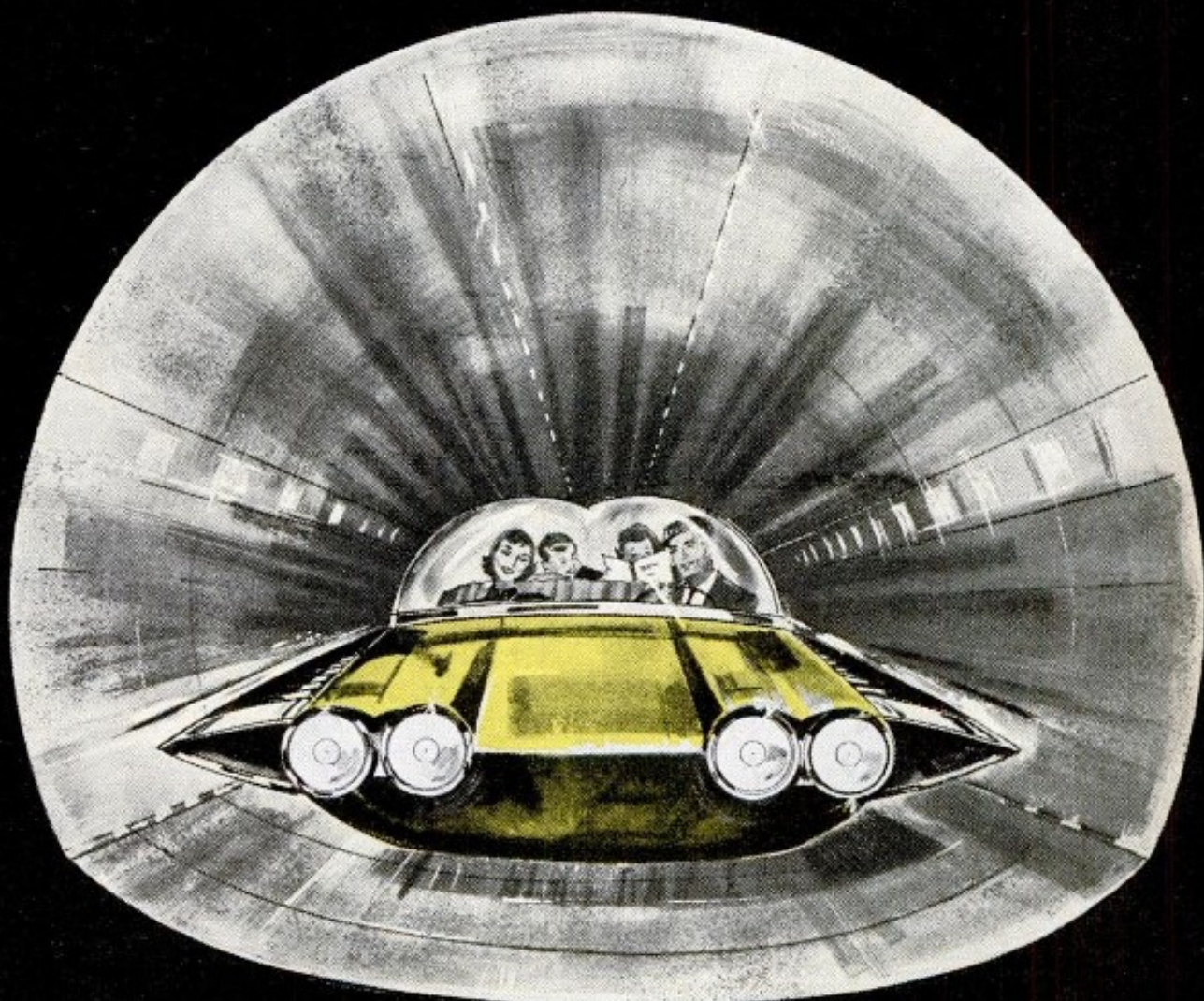
Build Your Own Kennedy Rocker

PAGE 118



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The fantastic future of travel: **1,500-m.p.h.** **Family Cars?**



Swept through Aeroduct pipe by a current of air, wheel-less cars could speed between cities.

The amazing future opened up by cars-without-wheels—the weird vehicles that glide inches off the ground on a film of compressed air—has excited the world. No one sees this revolutionary age more vividly than soft-spoken, determined Dr. William R. Bertelsen. A talented engineer as well as a Neponset, Ill., physician, Bertelsen has built some of the first and best of these remarkable machines. His newest model was bought by the U.S. Government for demonstration abroad.

On the following pages, he outlines for POPULAR SCIENCE readers a startling forecast for tomorrow's travel: family cars



that convert 3,000-mile trips into two-hour jaunts, that drive themselves automatically, that eliminate the parking problem. Unbelievable? You won't think so after reading his predictions.

CONTINUED

You'll cross the U.S. in two hours in an air car that steers and parks itself, predicts this pioneer designer

By William R. Bertelsen

FORGET that the wheel was ever invented, and imagine an ideal transportation system. Some possibilities will seem fantastic.

You want a machine that goes as fast as an airplane, but can't crash—and needs neither airports, roads, rails, nor harbors.

This futuristic car is already here: the GEM—ground-effect machine—such as the Aeromobile, which slides anywhere on a cushion of air. About 50 GEMs have already been built [PS, July '59].

The Aeromobile is the simplest powered vehicle: a motorized fan in a box with control flaps remotely controlled from the driver's seat. This is the entire mechanical system. There are no wheels, tires, axles, transmissions, differentials.

The GEM provides the smoothest possible ride. It is the most reliable vehicle because of its few moving parts and extreme simplicity. For the same reason it is the most economical to purchase, maintain, and operate.

The GEM operates over almost any surface. The ancient waterways—the Ganges, Amazon, Nile, Yellow River—become arteries of rapid, heavy traffic. Only a path is needed through jungle. Deserts and frozen wastes are thoroughfares.

But the most significant promise of the air-cushion machine is a completely



Suburbs could be linked by cheap "airways"

new traffic system, one in which safety, speeds, and total traffic can rise perhaps tenfold. Every mechanical and electronic principle involved is already in use today and available for the devices that I propose.

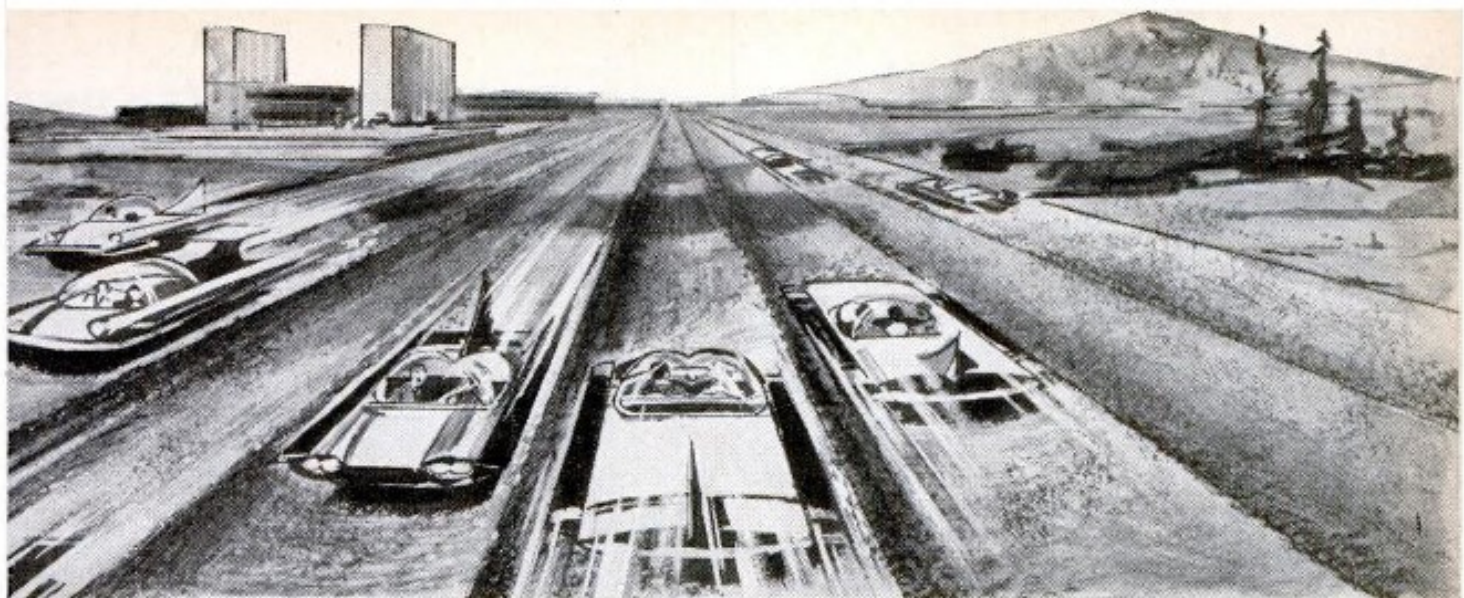
To begin with the simplest improvement, the Aeromobile can free people from bondage to conventional roads. The Aeromobile needs no gravel, no blacktop, no concrete. Suburbs could preserve rural beauty with nothing but broad grassy expanses leading from one town to the next. A clear, fairly level stretch of grass makes the ideal Aeromobile highway. Such highways—literally parkways—would be so cheap that a network could spread over enormous areas. The edge-to-edge dimensions of suburbs would increase and living space would expand.

Safer in the groove. The grass-paved airway would be much better—faster, safer, and more efficient—if it were shaped into shallow grooves. The Aeromobile centers itself in the groove, our tests show, and moves steadily forward at high speed without steering.

An eight-lane airway would be about 80 feet wide, the right-of-way now needed for four lanes of auto traffic. The parallel grooves, each about 18 inches deep and 10 feet wide, would accommodate 8-foot-wide vehicles. A driver would move to successively faster lanes toward the center as his speed rose. The outer lane should handle speeds to 50 m.p.h., the second lane 75 m.p.h., the third 100



NO-HANDS DRIVING is easy with wheel-less car—roadway groove holds it on course. Electronic controls would be needed only at junctions.



paved with grass instead of concrete. Grooved shape of lanes automatically guides air cars.

m.p.h., and the innermost lane 150 m.p.h.

Such an airway could handle a collective 750 m.p.h. (adding speeds of all eight lanes). In contrast, the more expensive four-lane auto road has a collective 280 m.p.h. (even assuming 70 m.p.h. in each lane).

But the GEM is an aircraft. It can go as fast as other aircraft, even through supersonic speeds. The revolutionary difference is that it flies just above the ground, gaining almost all the advantages of flight without the danger of flight.

Flying in a tube. At groove speeds above 150 m.p.h., wind and weather would cause trouble. It will be better to protect the groove by making it the bottom of a tube. A steel pipe laid on the surface, a concrete tube under ground or under water, an aluminum tube suspended across canyon or river—these would provide the safest and fastest road ever known.

As the volume of vehicles rises over the years it would become economical to pump air with the traffic to reduce power consumption and noise (sonic boom) of the individual car. Velocities of Mach 1 or Mach 2—twice the speed of sound—would then be possible.

A tube trip from New York to San Francisco at 1,500 m.p.h. would take two hours. There could be 3,000 vehicles spaced one mile apart across the U.S. They would arrive in New York or San Francisco at a rate of 1,500 per hour. With four passengers in each car, 12,000

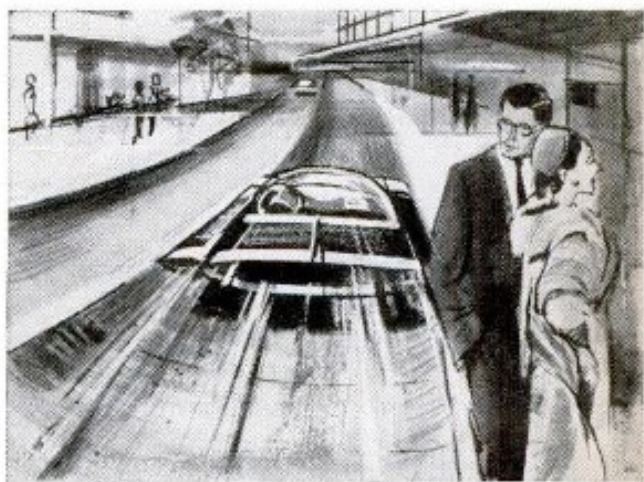
people could cross the continent every two hours.

An Aeroduct with forced air would allow the motorist to cut his engine down to fast idle—just enough to keep the machine airborne—and be swept along with the air current. This will save fuel.

Cars in the Aeroduct would be pushed along in fixed positions and spacing from each other at whatever speed the air is blown, be it 100 or 1,000 m.p.h. There can be no danger of collision since *all* traffic would move with its medium, like boats in the Tunnel of Love. Cars could move from one Mach 2 air stream into another with no sensation to the passengers.

The air flow in this long tube would have to be boosted every so many miles

[Continued on page 178]



DON'T PARK IT; SEND IT HOME. With simple automatic controls, you'd send car back to your garage empty to wait until you called it.

POPULAR SCIENCE

May 1949

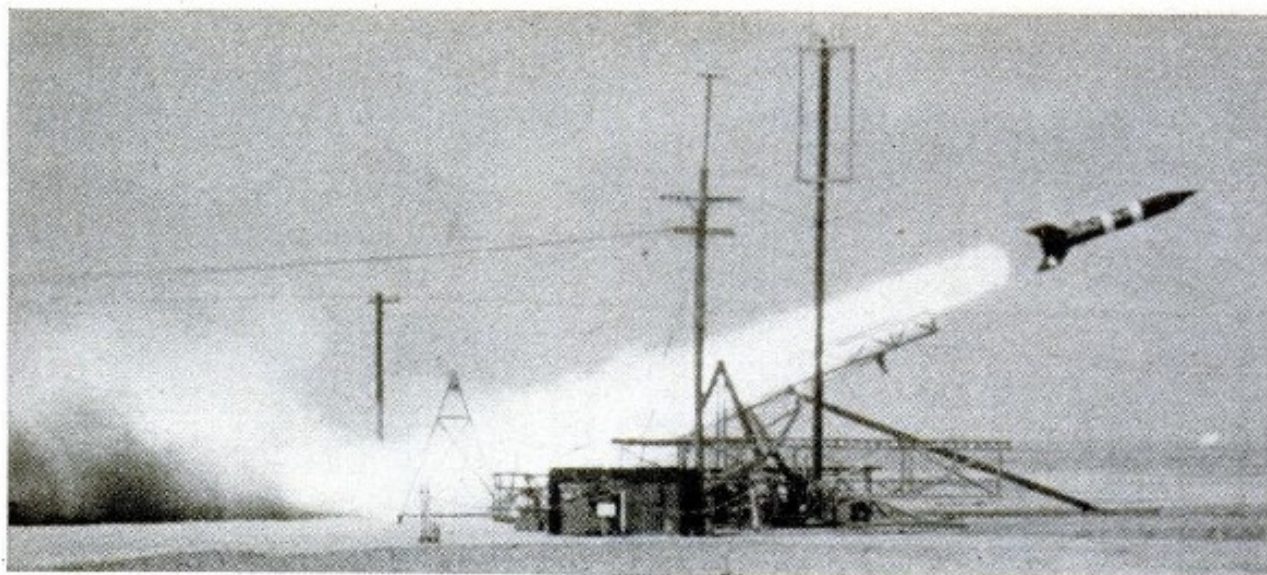
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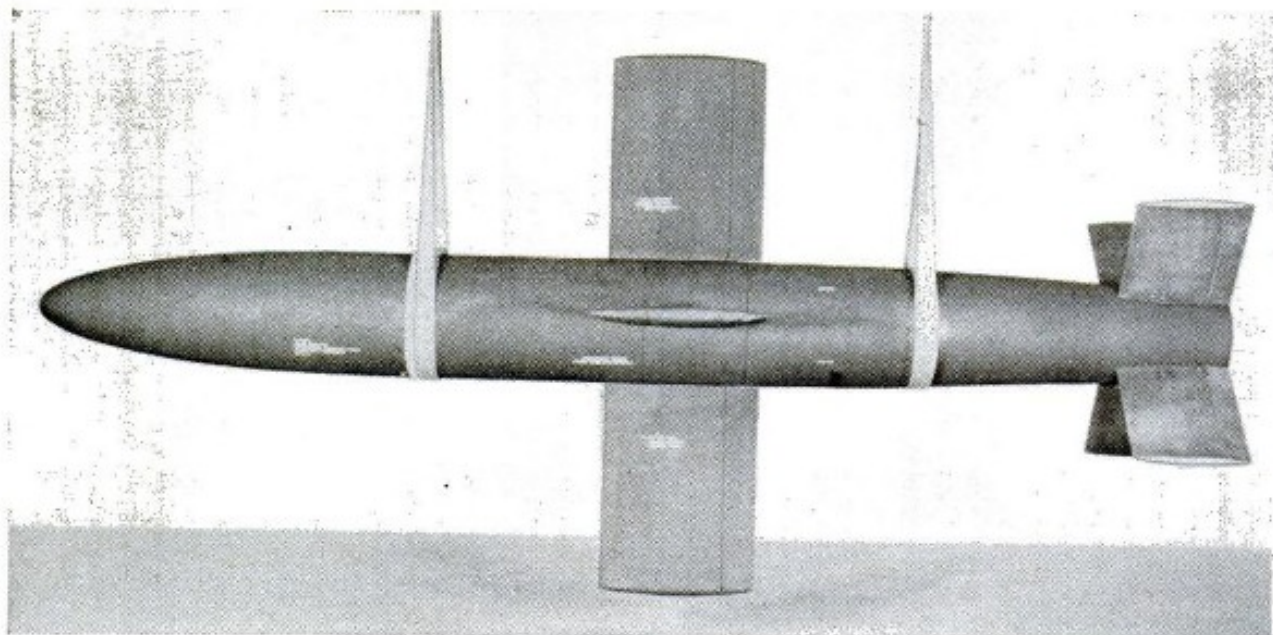
Is U. S. Building a "New Moon"?

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Swift Kick for Missiles

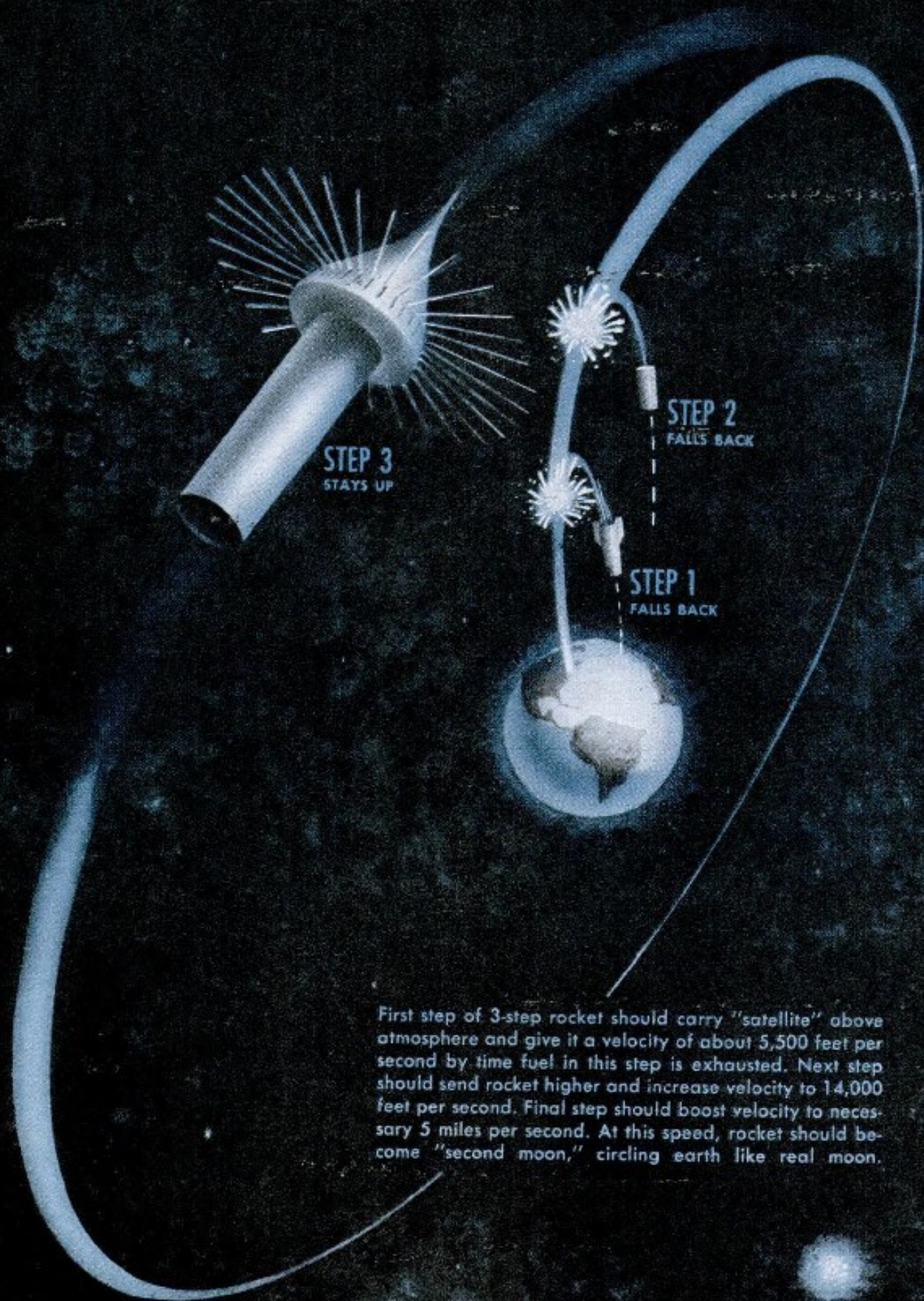
THE Navy's newest booster rocket, with a speed of more than 1,500 m.p.h., will get supersonic missiles off to a good start. It is designed especially for launching ramjet missiles that must reach near-supersonic velocity before they can operate efficiently. As shown on launching ramp at right, the solid-fuel rocket has a dummy nose. When the rocket is used as a booster, however, it will be attached to the tail of the main missile, then dropped off after the ramjet engine reaches self-operating speed.



Secret Weapon Previewed

SHOWN above, posing on its way for delivery to the U. S. Navy, is the Lark, latest weapon of push-button warfare. It is a ship-to-air, rocket-powered guided missile,

controlled automatically in flight. That is all the Navy will say about the new weapon, intended to knock targets out of the air, except that it has been designated the XSAM-N-2. Research and development is by Fairchild Engine and Airplane Corp.



First step of 3-step rocket should carry "satellite" above atmosphere and give it a velocity of about 5,500 feet per second by time fuel in this step is exhausted. Next step should send rocket higher and increase velocity to 14,000 feet per second. Final step should boost velocity to necessary 5 miles per second. At this speed, rocket should become "second moon," circling earth like real moon.

Armed Services Study 'Satellite Vehicle' Idea

By The United Press.

WASHINGTON, Dec. 29—

James Forrestal, Secretary of Defense, revealed tonight the existence of an "earth satellite vehicle program" within the Armed Forces.

He did not say if, but

Is U.S. Building a New Moon?

One rocket has already pierced the earth's atmosphere; a faster one might leave it and circle forever.

By Willy Ley

Author of "Rockets and Space Travel"

Drawings by Jere Donovan

THE Secretary of Defense has co-ordinated "earth satellite vehicle" research by the Army, Navy, and Air Force.

A 3,000-mile rocket-testing range has been requested.

Curtiss-Wright foresees a 10,000-m.p.h. "space ship."

Lockheed's chief engineer says: "Escape from the earth is far closer than most people think."

SUCH revelations made POPULAR SCIENCE editors ask: Is the United States now building a new moon?

No hints as clear as some of these preceded the first A-bomb's shock wave. Space ships, defense officials now say, are "a matter of highest secrecy." So the men who know exactly what's coming up and when are mum or enigmatic. Some of the rumors you may have heard, and some of the headlines, have been preposterous. But, beyond a shadow of possible doubt, American scientists and engineers are working on an "orbit-

POPULAR
SCIENCE



Cover drawing
by Ray Pioch

STEP 3

1,000 LB.	HULL AND PAYLOAD
2,500	FUEL
3,500	TOTAL

STEP 2

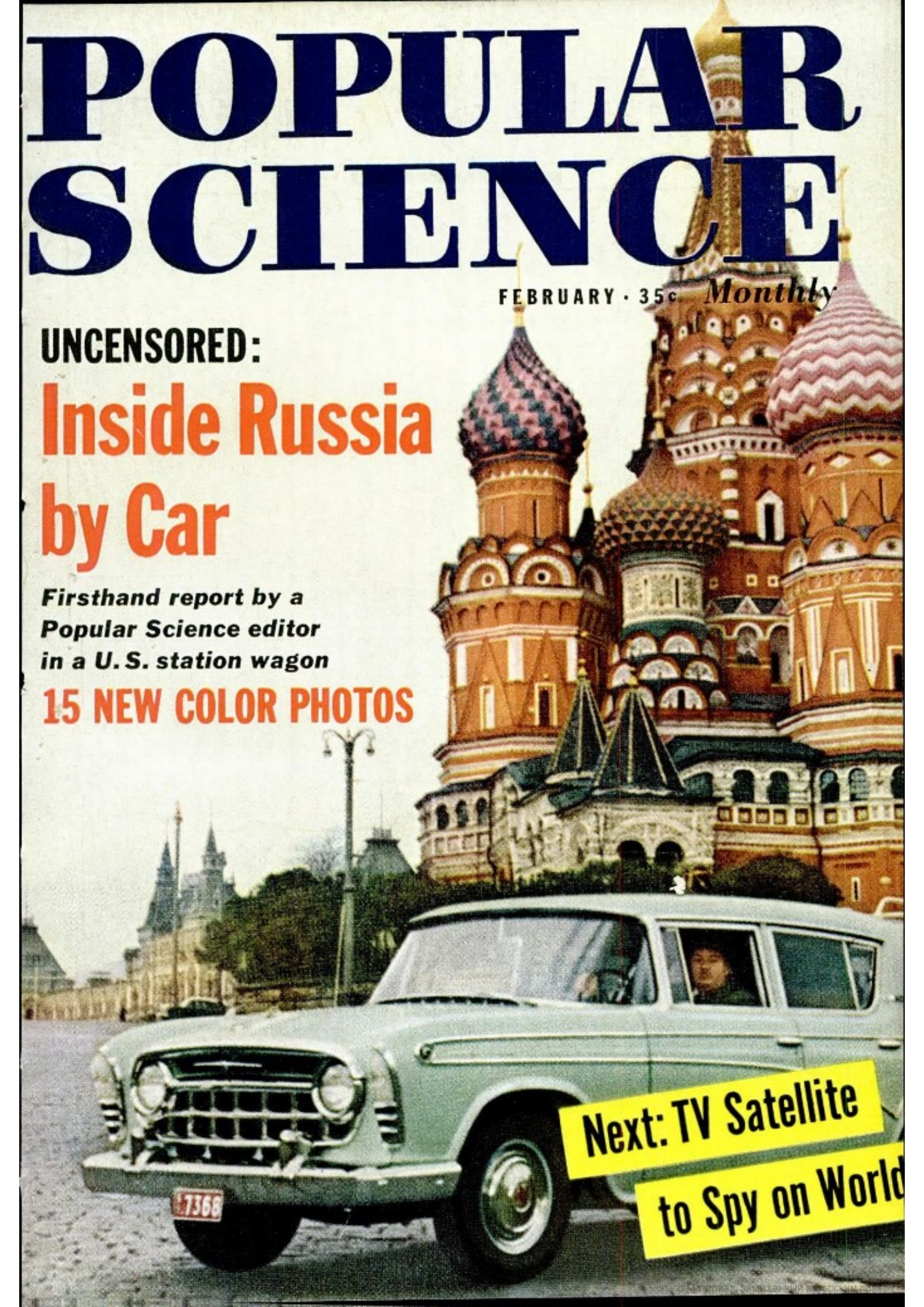
3,500	PAYLOAD
6,500	HULL
25,000	FUEL
35,000	TOTAL

STEP 1

35,000	PAYLOAD
30,000	HULL
162,500	FUEL
227,500 LB.	TOTAL TAKE-OFF WEIGHT

donovan

POPULAR SCIENCE



FEBRUARY • 35¢ *Monthly*

UNCENSORED:

Inside Russia by Car

*Firsthand report by a
Popular Science editor
in a U.S. station wagon*

15 NEW COLOR PHOTOS



**Next: TV Satellite
to Spy on World**

Popular Science Monthly

February, 1958

Cover photograph by Harry Walton



*What's this man doing?
Looking for spies. Here's the inside
story of espionage in Detroit*



*Now U.S. scientists hope
to rocket into space a
see-all, know-all TV eye.
Target date: any time... soon*

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In Yalta as in every other city our American station wagon was a magnet for crowds.



**POPULAR
SCIENCE**

REG. U. S. PAT. OFF. *Monthly*

A POPULAR SCIENCE editor's
uncensored report:

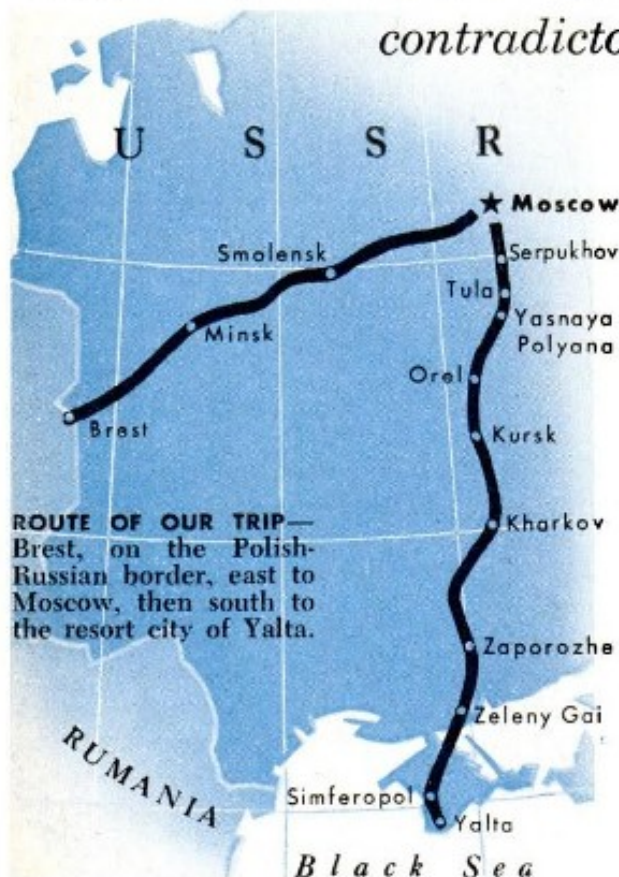
Inside Russia by Car

By Harry Walton

NOT another car was in sight as I pulled up at the loneliest border post I had ever seen. This was the beginning of an adventure into another world.

As the first American journalist to drive a U. S. car through the interior of the Soviet Union, my route would take me east to Moscow and south to the Black Sea—to such little-known cities as Kursk, Kharkov, Zaporozhe. Beyond, down the empty road that lay ahead, I was to find a strange and

"Ahead lay Soviet Russia, a strange and contradictory land . . . viewed through the



contradictory land—one of broad highways and tiny hamlets, of grim national police and obsequious service, of women laborers and pretentious hotels.

Traveling with me was Dennis Michael O'Connor, a graduate fellow at the Yale Law School, who had a working knowledge of the Russian language. Our car was a 1957 Rambler station wagon.

Cold, wind-driven rain fell from a gray sky as we rolled onto the iron-railed bridge that spans the Bug River between Poland and the USSR. Even before we reached the Russian side, a rifle-carrying young Soviet soldier stopped us with a stiff military gesture. I tried speaking German to him. He shook his head. I offered him a cigarette. He refused it.

A sudden gust of wind blew my hat off, and instinctively I started after it. But I was not to enter the Union of Soviet Socialist Republics so informally. "Nyet!" barked the guard, and sprinted after the hat himself.

Shortly afterward a Pobeda rolled up, stopped smartly. A hawk-faced young Russian officer got out and checked pass-

ports. We were told to follow—and drove in the Pobeda's tracks to the Russian city of Brest-Litovsk.

At the railroad station, the car was immediately a focus for curious eyes. We followed an officer into a huge marble-walled waiting room. Through the windows we caught glimpses of handsome, bright-green railroad cars, occasionally heard the treble piping of a Russian locomotive.

In a high-ceilinged room upstairs we met our guide and interpreter, Valentine Salin, a soft-spoken, slight man with impeccable manners. Our new Rambler was due for an oil change, so we asked about a service station. We were led by the Pobeda through an iron gateway into a huge concrete yard. Promptly every Russian in the place came up to the car, and the questions began.

Nyet, not Angliski. Aftomobile Americanski. Nyet, not Ford or Chevrolet. Marka Rr—rr-rambler (the Russians roll that first "r" with the best of them). Belgian plates because assembled in Belgium. Yes, new 1,951 kilometers ago.

Eyeing the drain pit with alarm—it was a deep gash in the concrete floor, with hardly two inches of guard rail—I drove over it under the stare of 40 Slavic eyes.

While O'Connor held forth to a fascinated audience around the opened hood, I clambered down into the pit myself. My notion was to make sure the mechanic drained the engine, not the transmission, and kept the copper gasket on the drain plug. I needn't have bothered; he did.

"Aren't you going to start the engine before putting in new oil?" a Russian asked O'Connor. "It works better." O'Connor told him *we* didn't do it that way. There was a little flurry, as air was being added to the tires, when the hose fitting parted. Embarrassed at this technological lapse, three mechanics scrambled around to join it, finally in desperation held it together by hand.

windshield of a U. S. car"



With goodbyes all around, we set formally off beyond the Iron Curtain. In the back seat was Salin—our guide, interpreter and (perhaps) private eye. I had an eerie what-am-I-doing-here? feeling.

My assignment was to drive 3,500 miles through Russia and report on how it differed from, say, a transcontinental U.S. trip. I started out with standard preconceptions: The roads would be terrible, the natives hostile, and I'd be in real trouble if anything broke on the wagon that couldn't be fixed by a tractor mechanic.

The preconceptions were wrong. The Russians I met were not hostile, and the roads and mechanics were first-rate. In several cities I met friendly, curious, wide-awake students, (including some who regularly read *POPULAR SCIENCE* in the technical library). Often I talked with earnest, unsmiling but not unfriendly adults who took to heart their government's much-repeated slogan: "Beat America." Everywhere I saw evidences of a dedicated national effort to cram into two decades the industrial revolution that has taken the West two centuries.

There is no speed limit in the USSR except through villages. The road east to Moscow is superb, more than wide enough for four cars abreast, with a well-maintained asphalt surface. Yet pedestrians, wagons and livestock made it imperative to reduce speed when dusk fell. In a land where the trucks rarely have working tail lights, you cannot expect them on cows. It is strange, too, that the country that first launched Sputniks hasn't given its bicyclists the humble but effective reflector button.

Tourists are privileged characters. In Minsk, we overlooked a no-passing sign and ran around a couple of trucks. Instantly an outraged militiaman (national police officer) thrust his baton downward in a gesture that would mean "pull over" in any language, and whistled us down, anger in every trill. We waited apprehensively as he stalked over. Our guide said

a few words. The militiaman saluted and walked away. "You see?" Salin said imperturbably. "He apologized."

You can turn right on red in Minsk but are not supposed to blow a horn. It is wise to beware of the red circle that means no entry, or else you may find yourself driving down a flight of stairs. Most traffic signs, fortunately, are pictorial ones, easy for foreigners to get.

We stayed that night in a grandiose hotel with an elevator about four feet square. Inward-opening doors on the car made things comically awkward at times—two passengers with luggage become a crowd. Control is by pushbutton, with an operator to do the pushing—and you either learn the Russian for figures up to five, or resort to the childish alternative of holding up fingers.

Rooms are big, high-ceilinged, with enormous double-sash windows and often a balcony. Sometimes the beds stand in a curtained alcove. Rugs and drapes abound but lack the cool smartness of those in Western hotels. Bathrooms are crude affairs with asthmatic plumbing and primitive fittings. The huge bathtub and generous towels are often negated by a lack of hot water. You can use an electric shaver if you have an adapter for the round-pronged receptacles. The juice is 50-cycle A.C. at 127 volts—on which U. S. shavers are willing to function.

Formal sightseeing was encouraged always. In Minsk, we stopped at the Park Kultury (Park of Culture) to see something called the Children's Railroad. The name is misleading, for it is a very respectable narrow-gauge line with several kilometers of track, signals, a dispatcher's office, real cars and man-sized steam locomotives. But it is operated by six-to-14-year-olds, who have to qualify for the privilege. There is class instruction, too, to be sure that the youngsters absorb information with their fun.

Good as the highways are in this part of Russia, they're no expressways. Herds

Text continued on page 100 . . . Exclusive photos on next six pages



Rolling country in the Crimea on the way to Yalta. Trucks are the workhorses of Russian



CO-EDS DIG A DITCH in the main street of Simferopol on their day of free labor for the state. Prettier than most women workers we saw,

they made a lark of it. Russian women work hard, not only as breadwinners but in daily food shopping that may take two hours or more.



highways. The kilometer post (in center, above) and guard posts are standard on main roads.



BALKY BOVINES BAR THE ROAD. But patience gets you through, sometimes with the help of the herder. Question: If a state-owned truck kills

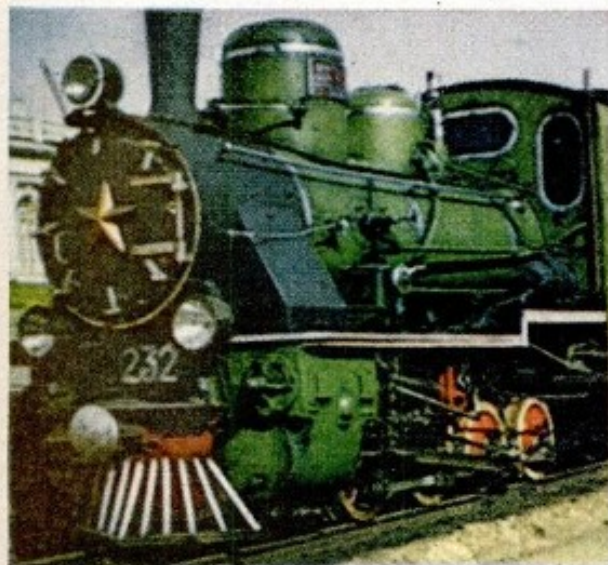
a state-owned cow, who sues whom? Or does the driver pay? Other roadblocks are slow wagons, unhurried flocks of geese and ducks.



COLORFUL ROADSIDE MAP in New Zaporozhe pictures production goals in the Ukraine under

the sixth five-year plan. Goods-hungry Soviet citizens feel they have a stake in statistics.

ENGINE OF CHILDREN'S RAILROAD in Minsk is no toy, but a 30-inch-gauge coal-burning steam locomotive. The kids' line at Kharkov is junking its oldest engine in favor of a new diesel.





SEWER FOR SIMFEROPOL. A dragline shovel helps excavate for pipe. Co-eds digging elsewhere

on this street asked why we didn't "shoot" the machine instead of them. So we did; here it is.

MOSCOW CROSSWALK. Traffic, squeezed right by posts that protect woman painting STOP on

the pavement, waits for light at Gorki Street. Area at lower right is mid-street safety strip.





SUNLIGHT ON THE KREMLIN, and shadow on a Moscow street. Autos may be few, but walks are always crowded.



MAIN POST OFFICE in Moscow announces International Letter Week, urges Ivan to write his friends and relatives.

RED SQUARE with St. Basil's (left) and one of five starred Kremlin towers. At right is the Stalin-Lenin tomb.



School kids at Yalta look over our



wagon, while one worried small boy and a curious blonde girl inspect the photographer.

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A soldier eyes the automobile Americanski. In this crowd at Kharkov, there's a station wagon

of plodding cows with no intention of yielding the right of way, trains of geese in stately single file, and both bikes and pedestrians wandering about unpredictably require a sharp eye on the road.

Then there are the flax threshers. I don't know what it's like to hit a foot-high layer of flax stalks at speed, because by luck we always slowed down in time. The women who sat by the road would wave us on over the stuff. After enough wheels have crunched it, the women pick the stalks out and make piles of the seed, which stays right there on the road until a truck comes along to pick it up. You aren't supposed to run over the seed—or hit the platform scale on the highway.

Road repairs are equally casual. Sometimes we encountered—hidden around curves, with neither sign nor flagmen to give warning—braking crises in the form of machines, gravel piles and work crews. The crews are predominantly female. Men drive tractors, dozers and rollers; the pick-and-shovel jobs are women's work. We even saw a railroad section gang of women. "Here," our guide explained, "they have equality."

Most motor traffic consists of olive-drab trucks with license numbers stenciled high on the tailgate. Some roll at 50 m.p.h., but many are slower. At crossroads, a driver who pulls to the middle of the road may (1) intend to swing wide into a right turn, (2) mean to turn left, or (3) simply like lots of room.

Russian drivers, of cars as well as trucks, are conscientious, actually, about signaling left turns on the highway. This they do by opening the left-hand door wide. Some even stick their heads out.

Our guide was apprehensive about overtaking trucks without warning. "Honk him! Honk him!" he would say tensely. Since outside mirrors apparently haven't yet been invented in the Soviet Union, this was good advice.

About overtaking America: There is no brand-name advertising on Russian roads—but there *are* billboards. The big posters and signs admonish the passerby to "Overtake America" or to "Work for World Peace." Others are exhortations to work harder, produce more, stop having accidents.

Directional road signs are big, clear and plentiful. Many include destination arrows that warn of turn-offs and show where they lead. Occasionally there is a big signboard strip map along the road (free gas-station maps are unheard of). Every kilometer along the main Russian highways is marked by a neat post with two mileage plates on it. One side shows the distance from Moscow, the other the distance from the provincial city at the far end. Concrete guard posts, drainage ditches, guard rails and warning signs are substantial and well kept.

Shy tourists should stay home, for any foreigner in the USSR is conspicuous, and one in a foreign car triply so. Our station wagon galvanized Russians into attention everywhere. Women stooping at work in the fields would straighten up to stare. School children plodding home at dusk from double sessions cried out in amazement. Whenever we pulled up on the road, people appeared from nowhere.

They all wanted to know the same things: what make the car was, how many cylinders the engine had, its horse-



(note open hood). At right, O'Connor reads children's names written in dust on the Rambler.

power, and the gas mileage we got. Heavily loaded and cruising at 60 m.p.h., we were getting 9½ kilometers to the liter, a figure that greatly impressed our hearers. (Ours was obviously a bigger car than their Pobeda, which takes more gas.)

The price of the car, which Russians asked shamelessly and we told them gladly, impressed them as a great bargain. The Russian Volga, a much smaller car, costs 30,000 rubles—a whopping \$7,500 at the official non-tourist rate of exchange, or three times the average worker's annual pay. Our Rambler delivered in Belgium at \$2,600.

Between Smolensk and Moscow, traffic thickened, and I was surprised by the number of prewar American cars in sight—until a closer look revealed the ZIS or ZIM on the hubcaps. (The ZIM is a copy of an old Buick, the ZIS of a Packard.)

In rush hours, Moscow traffic flows at quite an alarming pace on the city's broad boulevards (I clocked taxis at 55 m.p.h.). Driving is a battle of wits between motorists and pedestrians, who pay no heed to lights. Since horns are prohibited, a driver's chief weapon is outbluffing the crowds. He who hesitates behind the wheel is lost—in a maelstrom of foot traffic.

Drivers are far more rigidly controlled than pedestrians. On many major intersections you can't turn left (an arrow pointing straight up means no turn at all; if it has a branch, you can go straight, or turn as indicated only). Where no left is permitted, you turn right and then make a U-turn in a designated gap through the midstreet safety zone. This works fine.

A sign with a red bull's-eye and an

arrow pointing right means you wait to turn right on red. Some intersections have a row of four instead of three lenses in their traffic lights. The idea (and you'd better get it) is to wait for *two* greens to turn left.

It was time for a car wash when we reached Moscow. At the garage, two earnest, motherly little women in rubber boots and aprons took the Rambler in hand with spray hose and washcloths. Far too short to reach over the top, they flung the cloths up onto it and drew them down. When they were finished the car sparkled inside and out.

Russian mechanics, interested and helpful, made a new gasket for our leaky



SKOLKA? How many? The better, 74-octane gas was available only at a few special pumps.

jerry-can spout. But when I asked for an antifreeze hydrometer, they could only shrug their shoulders—and taste the stuff in the radiator instead. Savoring the coolant, they said it hadn't much antifreeze.

Every truck in the USSR seemed on its way south when we took off on the long haul for Yalta. To cover the long distances we drove after dark. Rolling country made night driving tricky; just over the crest of a hill often lurked a lightless wagon. Truck breakdowns seemed to call for conferences and repairs well out on the road, without flare or lantern to serve warning. But worst of all was the problem of dimming our own headlights. Even on low beam, they invariably provoked an angry blinking of lights from oncoming traffic. Finally it

dawned upon us that on approaching another vehicle we were not supposed to lower the beams, but to turn the headlights off entirely, driving by moonlight—if any. This may work with slow trucks; it puts a fast car in serious danger of hitting an unlighted obstacle.

Everywhere is the alert militiaman—not only at crossroads and in hamlets, but also standing on many a lonely country hilltop. Sometimes he has a motorcycle sidecar, complete with burp gun. The militiaman is cop, judge, court clerk all in one, for in the USSR, traffic court is held right on the road. Drivers who violate a traffic law pay their fine on the spot. The officer gives the offender a receipt and punches his driving license.

The third night of our trip south we

How Communism Threatens Russian Science

Condensed from "A Report on Science in Russia Today" by Dr. Tom Margerison, scientific editor of the British magazine *The New Scientist*, who visited Russia about the same time as *POPULAR SCIENCE*'s Harry Walton.

NOBODY who visited Russia without prior knowledge of her prominent position in science would dream that a country in which petty officialdom and inefficiency are still so evident could beat the world in the launching of earth satellites. Scientists are now probably the most pampered profession in Russia. They receive salaries as high as, or higher than, leading artists of the stage and screen.

The result is that there is great competition to join their ranks. The universities are inundated with students wanting to study science subjects. The prizes of an assured position, a salary sufficient to buy a car, and other comforts, spur the students to hard work.

One rather sinister fact about the education of Russian scientists is that at every stage in their career they are required to prove their competence in the Marxist-Leninist doctrine. Entrance to a university is reserved only for those who can pass their political examination. Entrance on a post-graduate course depends on the results of yet another political examination.

Trying to arrange a visit to a laboratory or research institute involves a series of tussles with officialdom. Inside, I might have been in any British university laboratory—but for the red banners, carrying Communist Party slogans in celebration of the fortieth anniversary of the revolution, plastered bizarrely across the walls.

Basic research in the Soviet Union is carried out mainly in the laboratories and research institutes of the Academy of Sciences,

and of the 13 provincial academies. The budget for each institute seems to be flexible and, provided the Academy agrees, there is little difficulty in obtaining additional money for special projects.

The Academy thus wields very great power. Recently, it has been stressing the unity of the Party and the scientists, and has, apparently, been attempting to increase political activity among the scientists.

A. Topchiyev, the secretary of the Academy, said recently in an article in *Kommunist*: "To fight idealistic views and trends, tirelessly to expose idealistic conceptions, is the duty not only of representatives of the social scientists but also of scientists working in all spheres. We must energetically rebuff all revisionists of the Marxist-Leninist teaching..."

If this nonsense, written by one of the most influential men in the Academy, is to be taken seriously, it means that the future of Soviet science is less bright than most people believe. It means that the Communist Party is trying to set foot in the laboratories and gain control of them in the same way that it has been doing in the armed forces.

Science cannot be conducted in this way, and I am sure that the majority of the Russian scientists realize it.

Three things have brought Soviet science to its present thriving state. First, the government is prepared to spend money on it. Secondly, it gives scientists the privilege of a higher standard of living and greater freedom of movement than most other people. Thirdly, the scientific secretaries and administrators form a barricade inside which scientific thought flourishes without concern for the party line.

It looks as though this barricade may soon be swamped. If things go on in this way we may yet see a marked decline in the standard of Russian science.



Moscow's Manezh Square on a rainy day, Historical Museum and (top right) part of Kremlin.

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stopped at what Salin, our guide, said was a resort hotel. (O'Connor, surveying the plumbing, dubbed it the Last Resort.) Zeleny Gai is a stop for the big through buses, diesels, that roll from Moscow to Simferopol with two relief drivers and loads of sober-faced Russian vacationists aboard. The hotel, only six years old, was already shedding plaster, and the plumbing was deplorable.

The road runs arrow-straight for miles south of Zeleny Gai. Looking at the roll-



CAR WASH IN KHARKOV: This Intourist chauffeur hosed down the Rambler in the hotel yard.

ing wheat lands, you could imagine yourself in the American Dakotas, until you ran across a knot of long-skirted, quilt-coated farm workers waiting for a bus or holding out a hand, palm up—a startling gesture that turned out to be the Soviet version of the hitch-hiker's thumb.

Gas is where you find it in the USSR. And not just any gas station will do. Most dispense a low-octane juice as full of pings as borsch is of cabbage. We had to use it just once, and to the Rambler's eternal credit it swallowed the stuff, protesting mildly.

The "high-test" gas is 74 octane, available only from certain pumps in specific stations—and possibly only to tourists. On this the car ran fine; for we had asked the Brussels assembly plant to detune the engine to take it.

For those occasions when the special pump wasn't working or the tank was empty of 74-octane, we carried 20-liter jerry cans. They came in handy a couple

of times, making it possible for us to go on rather than accept the liquid horrors that satisfy Russian engines.

Gas pumps (which, for some reason, you aren't supposed to photograph) are ancient, dirty, usually hand-operated. Some were made in Germany, possibly before World War I. As the operator works a pump lever, gas flows into one of two glass flasks, while the previously filled one drains its measured volume into the car.

From Simferopol to Yalta is only 100 kilometers, but the road climbs two mountain ranges and snakes through a valley between them. The highway narrows down, with some widening at curves, but shoulders drop off into gulleys and driving is a matter of sawing the wheel continuously, with hardly 300 feet of straight stretch anywhere.

What had been drizzle turned into rain as we began to climb. Clouds wreathing the peaks had descended as fog, so that we reached the city, a maze of narrow one-way streets, late, tired and irritable.

By daylight the mountain drive back north was easier and the scenery magnificent. In Simferopol a huge ditch down the main street was being filled in by some 30 good-looking girls, rather awkwardly wielding picks and shovels. When I produced a camera, they glowered and turned away. They were college students, giving a day's labor to the state. Perhaps they were unwilling to have a foreigner photograph what they thought might be construed unfavorably—or, more likely, plain female vanity was at work.

Farther north, we ran across evidences of private enterprise: women and children selling melons along the highway. As we passed a road-repair crew, a young woman bellowed enthusiastically at us. I asked what she had said. O'Connor translated: "What a car!"

To Russian officials, the Rambler was evidently a source of embarrassment. We were repeatedly asked to park it out of sight behind locked gates. In Kursk, a militiaman appealed to a large crowd: "Comrades, don't just stand here looking at this car. You have work to do. And you children should be going to school. Move on." Nobody budged—it was the militiaman who rather sadly moved on.

Outside a tiny village north of Zapo-

[Continued on page 234]

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rozhe we were stopped decisively by a militiaman. As we waited, the first of a strange procession appeared—two men carrying red flags, then two others carrying medals on red-velvet panels. Next came women bearing vast floral pieces, followed by perhaps 200 men, women and children and a small brass section playing stirring yet melancholy music. The slow procession trudged solemnly up a slope. Finally came a wooden casket, carried by several bearers.

Russian drivers are different. They are less competitive than we are, except in Moscow's heavy traffic. They are also notably helpful; if you run out of gas, you put an empty jerry can on the car roof—it will stop the first truck that goes by. And they seem rather fatalistic about breakdowns. Russian trucks get run to death before they rate an overhaul, so that many an off-the-cuff repair has to be made on the road. Russian mechanics impressed me. We had a difficult welding job done in Moscow; it turned out excellently. We also had a tubeless tire repaired there. The mechanic (who had never seen one before) not only fixed it, but achieved an airtight seal when he remounted it—he checked it in water to make sure.

To escape Zeleny Gai (O'Connor's Last Resort) on the trip back, we drove to Zaporozhe instead. It was here, on a Sunday night, that two teen-age machinist apprentices came up to us on the street and told us elatedly of Sputnik I. Later on, after our return to Moscow, we were approached by four students who had spotted us as foreigners and wanted to talk. I produced a copy of POPULAR SCIENCE with color photos of 1958 U. S. cars. Though calmly proud of Sputnik, the youngsters were frankly envious. "We won't have cars like that for two years," said one student. "Two?" scoffed another. "Ten would be nearer."

Because we had overstayed our visas, there were hints that we might have some trouble leaving the country. It didn't develop. We were courteously cleared at the Bug River bridge, and bade our guide and friend of three weeks goodbye. There was no inspection. We were allowed to take out all our film, to develop our impressions of Russia back home. **END**

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Popular Science

Monthly

'65 Cars:

Big Changes Ahead?

PAGE 40

"Say, Smokey—"

**America's Most Famous
Mechanic Helps You Get
More Out of Your Car**

**AMAZING NEW
WHEEL
TURNS
ITSELF**

PAGE 44

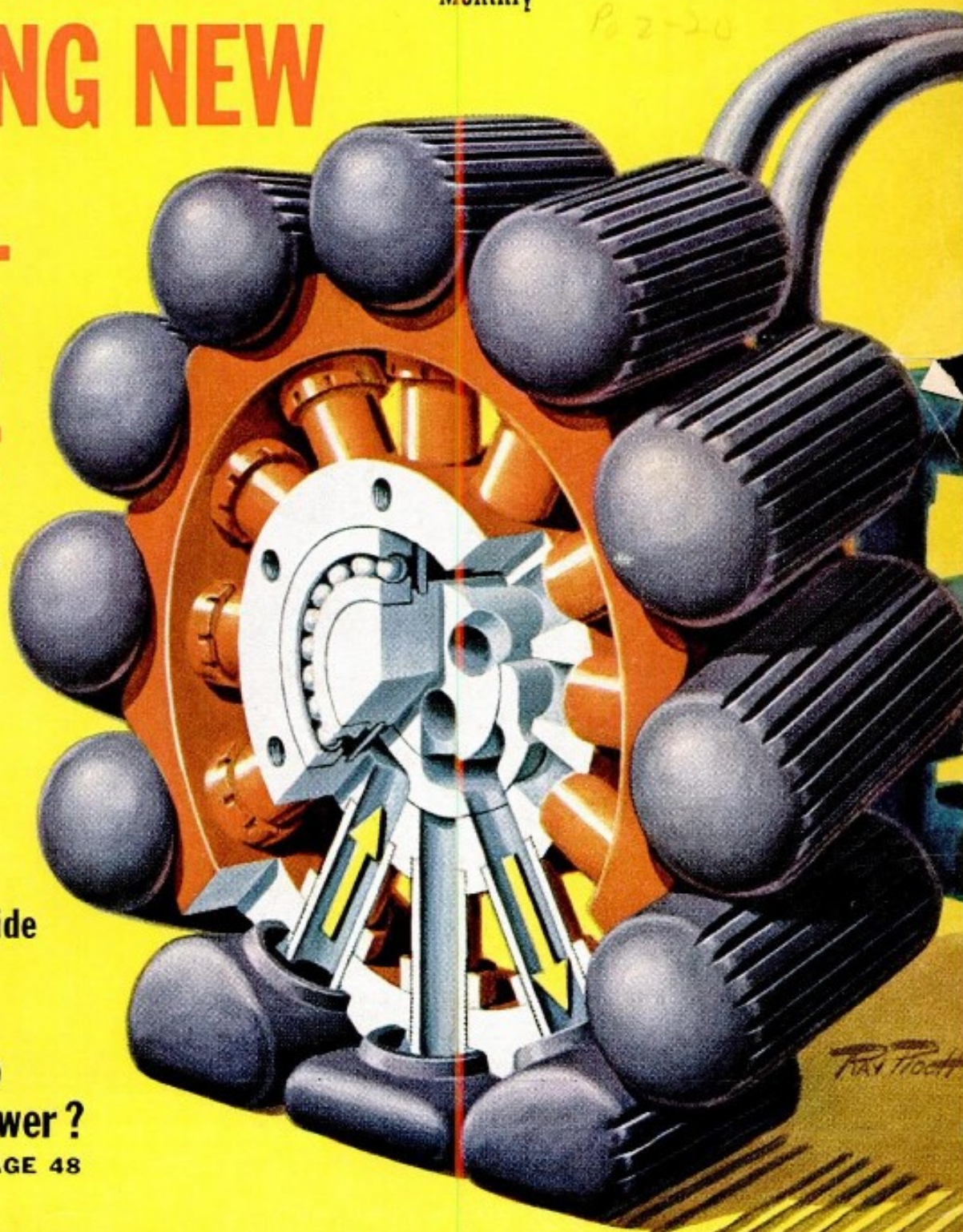
**Dangerous
Dams—
Disasters
Waiting to
Happen**

**A Startling Nationwide
Report by PS**

**What Happens to
All That Horsepower?**

PAGE 48

Tools for Working On Your Car—12 Pages



This Walking Wheel Turns



Sausage-shaped air bags, differentially inflated by a compressed-air tank, propel 18-inch-long model of a walking-wheel vehicle. Deep and broad tread pattern on ground testifies to ex-

cellent traction on rough terrain. Tests show that optimum hill climbing and acceleration are obtained when overall wheel diameter, relative to rim diameter, is as large as possible.

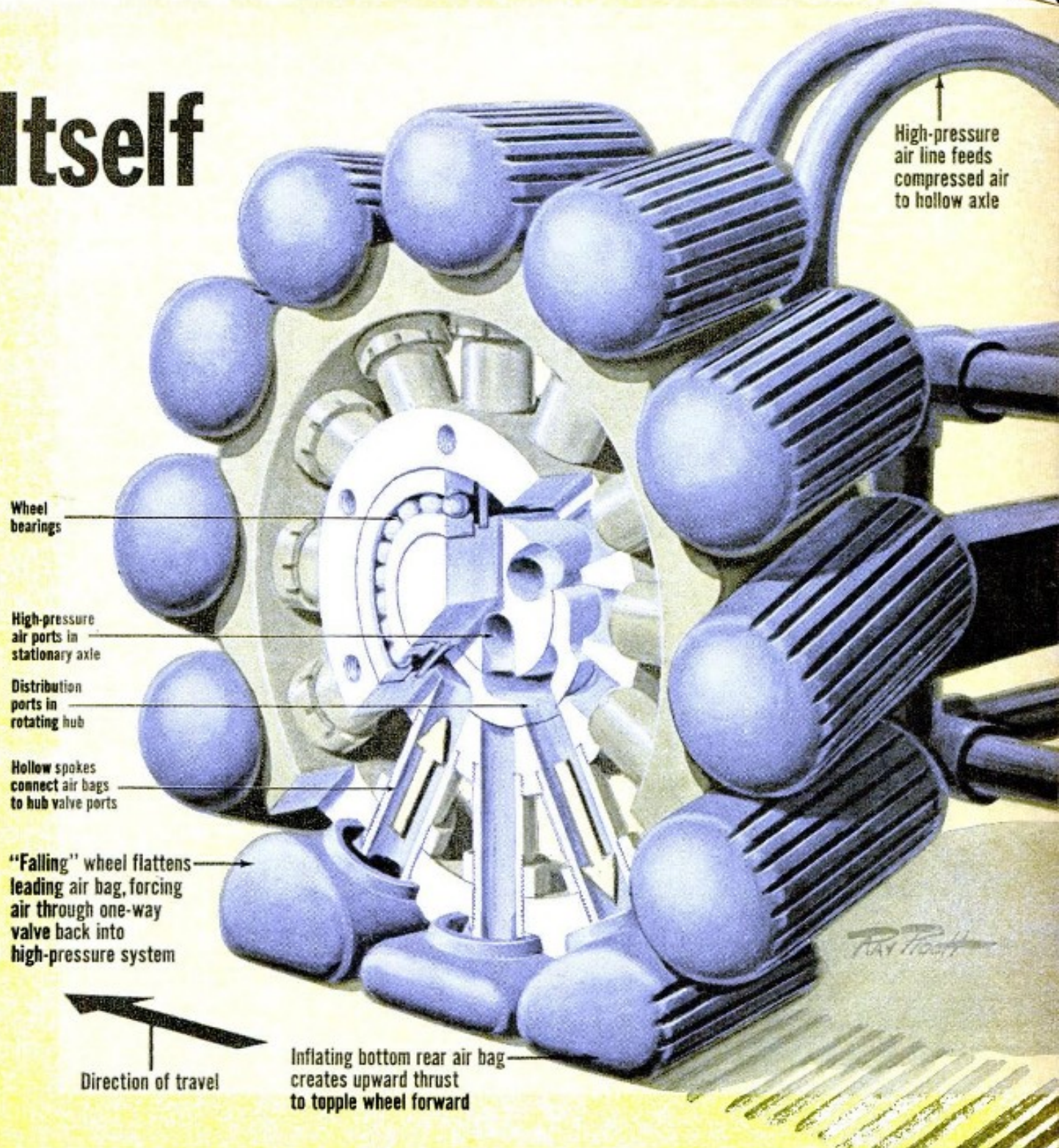
By David Scott
EUROPEAN EDITOR

A REVOLUTIONARY form of locomotion—a wheel that drives itself the way a man walks—has been developed in Czechoslovakia. Its self-propulsion eliminates the usual car transmission, prop shaft, and differential with their hefty losses, waste of space, and undesirable weight. Rolling resistance is greatly reduced; the wheel won't spin under power either on ice or mud or

when it bounces off the road into the air; and there is no torque reaction to the axle and chassis.

Basically, the wheel relies for traction on gravity rather than friction. Researchers of the Motor Vehicle Research Institute in Prague who developed the self-turning wheel took the way humans walk as a model: The supporting foot rests on the ground behind the center of gravity, and the body falls forward until checked by the other foot.

Itself



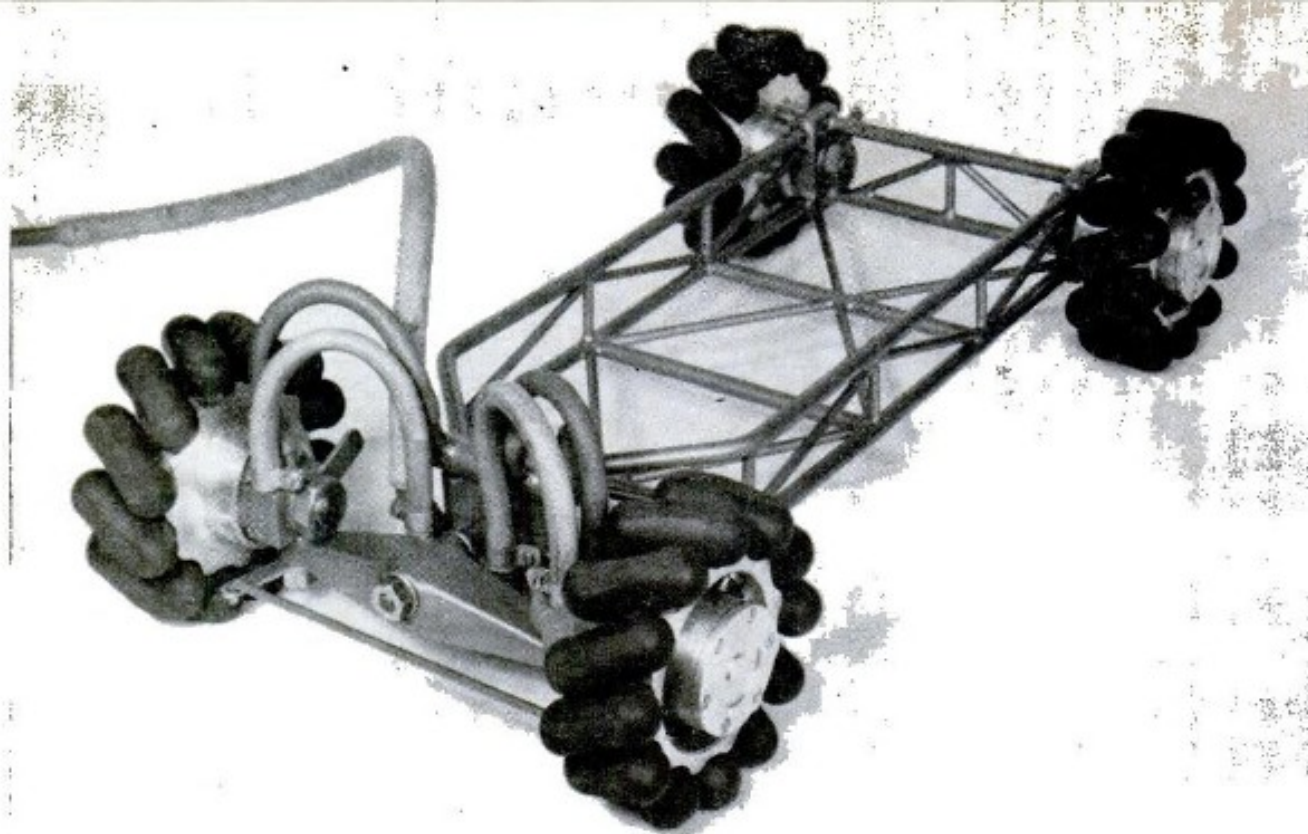
Adapted to a wheel, the principle concentrates driving power in the spot of contact between tire and ground. Cutting out all the gears in the drive train saves the engine power that they waste—as much as 20 percent.

Instead of a conventional tire, the Czech wheel is shod with a ring of individual air bags. Inflating the bags to different pressures makes it rotate. Full pressure is applied to the underside bag behind the axis, throwing the wheel off-

balance and causing it to topple—or roll—forward.

The bag directly beneath the hub is meanwhile partly inflated to cushion the ride. As the wheel rotates, the sequence repeats to provide continuous movement, and pressure is reduced in each compartment as it leaves the ground.

Differential inflation is automatic. Compressed air is piped through the stationary axle shaft to distribution ports in the hub connecting with the individual bags.



Four-wheel-drive test model, shown without its compressed-air tank, may be the forerunner of a new breed of cross-country vehicles. Besides

excellent traction, walking-wheel design offers low ground pressure thanks to light weight and the large surface area resting on the ground.

The turning of the wheel opens and closes the rotary valves.

To prove the theory, the research engineers built an 18-inch-long four-wheel-drive model. Tires consist of 12 cylindrical compartments resembling sausages. These are pitched at an angle around the rim like the teeth of a helical gear, so that ground contact between adjacent bags overlaps slightly to avoid a jogging movement.

Power is from a compressed-air bottle, and the tubular frame of the model serves as ducting. Air is piped to and from the wheels in a closed circuit, and pressure released from the deflated bags is returned to the system through one-way valves to minimize losses and power requirements.

Fast movers ahead. The Czechs believe cross-country vehicles will be the first likely application of the new design because it combines exceptional traction with low ground pressure—the result of light weight and wide tires. The power source might be an air compressor driven by a small piston engine or a gas turbine.

The drive needn't be limited to slow movers, however. Cheap-to-run cars,

with solar energy providing hot air for propulsion, are envisaged.

Speed would be controlled by regulating the air pressure. Radially moving inlet-distribution valves on the axles could be shifted to vary the effective torque like a conventional gearbox. Reverse would be obtained by altering valve timing to inflate tire compartments in front of the wheel hubs.

Gradual shift from forward to reverse drive might be used for engine braking.

For coasting, you'd just cut the power, and the bags would continue to inflate and deflate themselves through the closed-circuit piping. Alternatively, all bags might be blown up to equal pressure, when braking normally.

Though the self-driven wheel is in its infancy, it suggests several practical advantages. Four-wheel steering as well as drive would be simple, as there is no mechanical transmission to limit wheel angles. Crablike movement for overtaking or parking might be possible. A puncture would be confined to one compartment, which could be replaced without jacking up the car or removing the wheel. You'd need no bulky spare. ■ ■

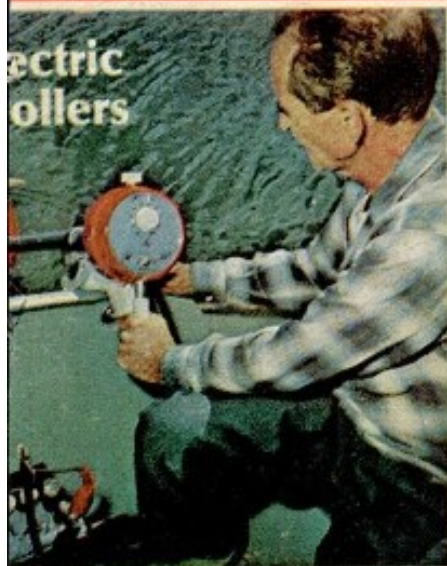
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THE *What's New* MAGAZINE

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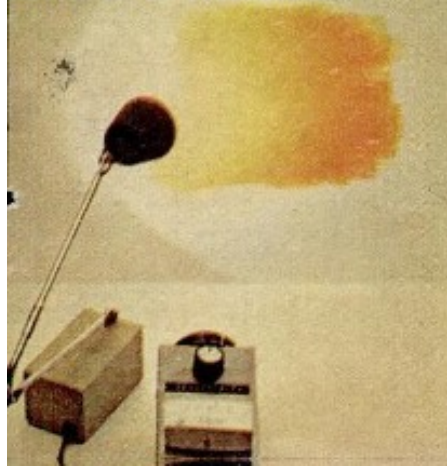
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WHAT IT'S LIKE TO FLY
THE NEW JET BELT

By Test Pilot Robert Courter

Материал заимствован из журнала "Популярная Наука"



An exclusive report, by the only man to try the famed Rocket Belt's sensational successor, tells how it turns you into a jet-engined flying machine — and what you can do with it

What It's Like to Fly the New JET BELT

By Test Pilot Robert Courter

*Chief of Small Lift Devices Flight Test and Operations
Bell Aerosystems Company Division of Textron Inc.*

When Buck Rogers zoomed across the comic pages with his trusty flying belt, a few decades ago, his "25th century" style of locomotion looked as unlikely as the prospect of flying to the moon. But fact has overtaken science fiction. Now—like going to the moon—a practical flying belt is for real.

On April 7, 1969, I piloted Bell's new Jet Flying Belt on its first manned free flight at Niagara Falls, N.Y.—by coincidence, the "capital city of Earth" in Buck Rogers' adventures.

Put on the Jet Belt, powered by the world's smallest fanjet engine—and you become a flying machine, without need of wings. Says Textron's Bell Aerosystems Company, which developed the Jet Belt under a U.S. Army contract sponsored by

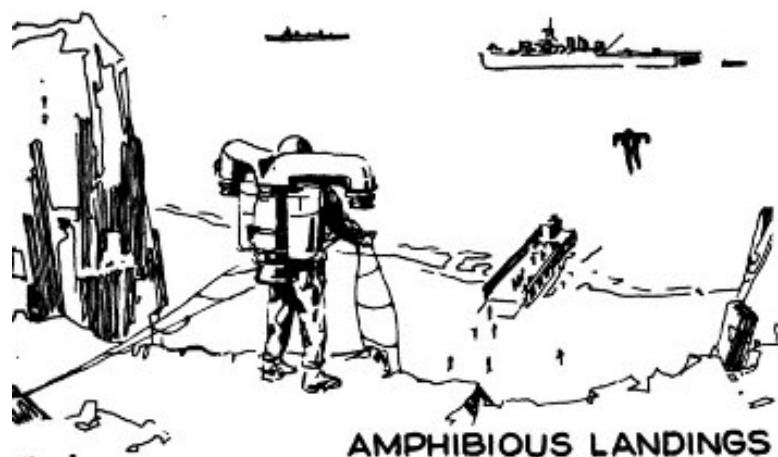
the Advanced Research Projects Agency:

"The new mobility system will enable men to fly over rivers, cliffs, and canyons, or such man-made obstacles as mine fields, barbed wire, buildings, and highway traffic. The scope of military and civilian applications is limited only by the imagination and ingenuity of potential users.

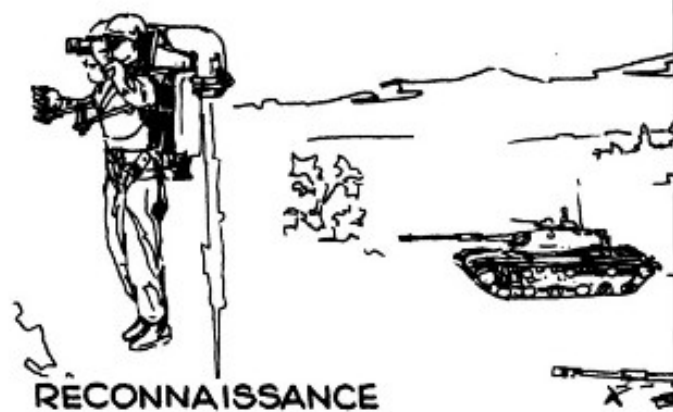
"Reconnaissance, artillery spotting, counterterrorism warfare, ship-to-shore operations, and perimeter defense are military operations considered within the Jet Belt's capability. Civil applications include traffic and riot control, fire-fighting, rescue operations, rooftop and high-building patrols. . ."

Conceivably the Jet Belt could even become the commuter's vehicle of tomorrow.

Continued



AMPHIBIOUS LANDINGS



RECONNAISSANCE



FOREST-FIRE INSPECTION



RESCUES

Jet Belt will have military and civilian uses

Here are examples of Jet Belt's applications. It could fly fighters to strategic spots to aid an amphibious landing, and ahead of advancing force to scout out enemy. Civilian user could speed to forest-

fire scene for report to guide firefighters, or carry rescue line to men on stranded ship. Cliffs, canyons, and bodies of water offer no obstacles to a man in a hurry who has this personal flying device.

Maybe someday your "second car" will be a flying belt garaged in the hall closet.

The new Jet Belt is a successor, with vastly improved capabilities, of Bell's famous Rocket Belt.

It was the Rocket Belt that first realized man's age-old dream of flying without an aircraft, almost as free as a bird [PS, Dec. '61]. Since 1962, when I joined the Bell company as a test pilot, I have logged well over 1,000 Rocket Belt flights myself.

With the Rocket Belt you can soar as high as 100 feet and at more than 60 m.p.h. But its hydrogen peroxide propellant lasts for only 21 seconds of free flight, and its range of about 300 yards is obviously too limited for a practical individual-mobility system. A flying belt plainly needs a less fuel-hungry power plant.

The answer is the Jet Belt's midget jet engine. It burns standard kerosene-type

jet fuel. Consumption is low. Compared with the Rocket Belt, the endurance of the new Jet Belt is measured in minutes instead of seconds—and its range, in miles instead of yards.

Flying the Jet Belt. What is it like to fly with the jet version? First, you can be your own ground crew—unlike the Rocket-Belt pilot, who needed a couple of skilled technicians to service his vehicle and to handle its ticklishly unstable fuel safely.

I back into a fiberglass "corset" and strap myself into the harness of the Jet Belt. While I'm doing this, a retractable stand supports it on the ground. (At first, before it was provided with a built-in stand, a separate one on the ground served the purpose; that is why you do not see a stand on the Jet Belt in the flight photo on the opposite page.)

To start the miniature engine, I trigger a solid-propellant cartridge that

spins it and ignites the fuel.

With the throttle, a twist grip in my right hand, set at "ground idle" position, I check controls and instruments. I advance the throttle to "flight idle," and lift just offsets the weight of the belt, making it easy to move about on the ground. Before lift-off I recheck the instruments, and retract the stand.

Then I ease the throttle up. I feel myself getting light on my feet. The r.p.m. increase. I lift off, rising like an elevator.

Four or five feet up, I'm above range of ground effects—bounce from exhaust gas ricocheting from the ground—and can stabilize my flight.

How you steer. To govern attitude, and provide motive force to move in any horizontal direction, the engine's gimbaled exhaust nozzles may be deflected from pointing vertically downward, by several controls—a left-hand twist grip (for yaw control) and a pair of handlebar-like control arms (for pitch and roll control). The right-hand grip, the throttle, varies thrust to ascend or descend.

By using these controls I can fly in any desired direction—forward or backward, left or right, up or down. I can make a coordinated turn, spin on my own vertical axis, or hover at a virtual standstill.

Moving around in the "wild blue" with no airplane under you gives you a

Continued

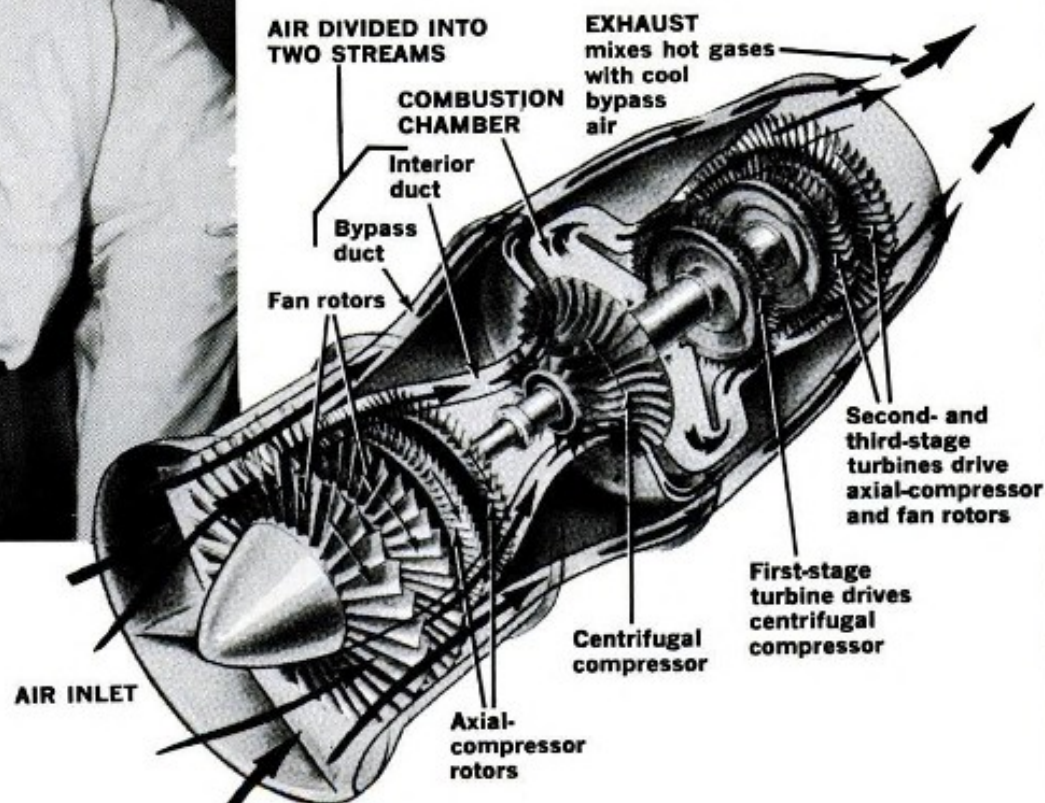


Author takes to air with new Jet Belt—which will fly him for minutes and miles. Here he's in full flight, using twist grips and a pair of handlebar-like control arms to steer himself in direction he wants to go.



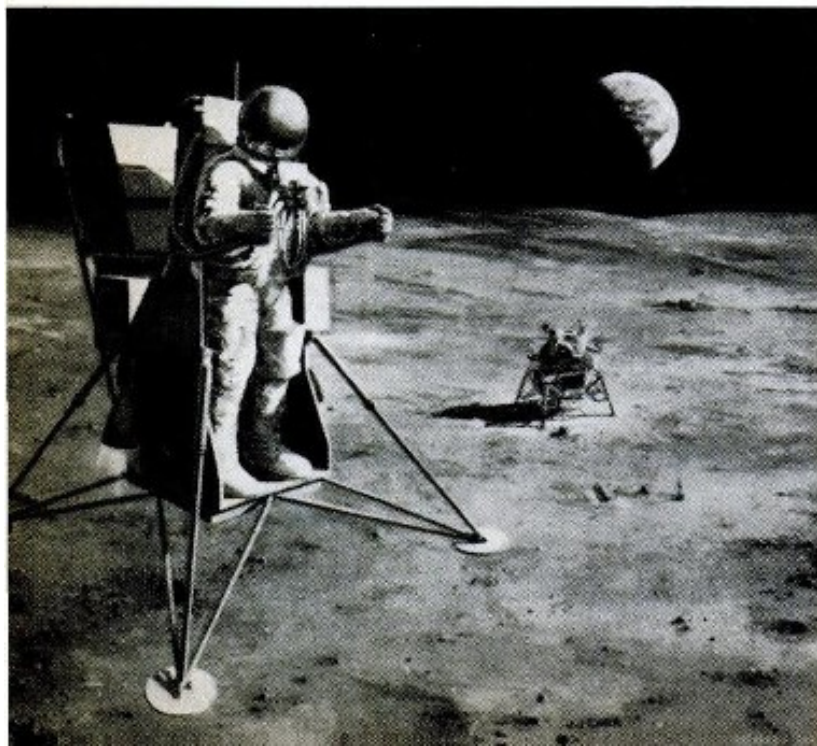
Jet Belt harnesses midget engine

Fanjet engine of new belt, being fitted with exhaust duct in photo at left, measures only a foot in diameter and two feet long. Cutaway view of it below shows how divided air stream gives cool shell and exhaust. Components' counter-rotation avoids gyro effect that would hinder maneuvering.



strange sensation. Lift-off with a flying belt is "like having a giant pick you up by the arms," as Peter Kedzierski, one of the first men to free-fly the Rocket Belt, once put it. Once you're up there, soaring as if exempt from gravity, there's a sense

Lunar Flying Vehicle being designed by Bell for NASA is latest rocket-powered offspring of Rocket Belt. Using left-over Lunar Module fuel, it is to carry a moon-exploring astronaut as far as 15 miles.



of freedom that reminds me of skin diving.

With the Rocket Belt's brief flights, I was too rushed to really enjoy the ride. Piloting the Jet Belt is more fun. It gives me lots of time for maneuvering, and I can fly relaxed. There is no perceptible vibration. The ride is smooth.

It may seem odd, but I have a comfortable feeling of security aloft with a flying belt. I actually feel safer than I do driving the family car in traffic. After seven years' first-hand experience with flying belts, I have a great deal of confidence in the system's reliability.

When I'm ready to land, I move the control arms upward to decelerate, set up a rate of descent, pick out my landing spot, and keep it in sight. I gradually brake the rate of descent until I'm almost hovering where I want to set down. Easing over to it, I can put myself down gently on a target a foot square.

After landing, I throttle down the engine to "flight idle" and walk to where I'm going to park the vehicle. Then I return the throttle to "ground idle." I put down the stand, shut off the engine, and get out

First came Rocket Belt — then, versions like Flying Chair and Pogo

of the harness, to become again an earthbound human like other men.

It's all quite simple. Anyone who really wants to learn to fly the Jet Belt should be able to do it in a few weeks.

Story behind Jet Belt spans 16 years. Both the Jet Belt and its predecessor, the Rocket Belt, were invented by Wendell F. Moore, Bell's assistant chief engineer. The Bell flying-belt story begins in 1953, when Moore first gave the idea serious thought. Research and development proceeded slowly, and the first manned free flight with the Rocket Belt was made on April 20, 1961. Pilot Harold Graham flew it for 13 seconds and to a distance of only 112 feet, not quite as far as the Wright brothers' first powered flight—but he made aviation history that day.

A 1960 development contract awarded Bell Aerosystems by the U.S. Army Transportation Research and Engineering Command had specified: "Build an SRLD [Small Rocket Lift Device] and demonstrate its feasibility in manned flight." And demonstrate it we did, to the Army and the world. In the years that followed the Rocket Belt's first trial, it proved its 100-percent reliability in more than 3,000 demonstration flights, witnessed by millions of people all over the globe.

As captain of a world-touring Bell Rocket Belt team, I've flown in most major U.S. cities, and in foreign countries on four continents. I demonstrated the Rocket Belt at the Tivoli in Copenhagen, at the Paris Air Show, at the first Super Bowl game in Los Angeles, and at the Royal Easter Show in Sydney. The 1964 New York World's Fair saw me rocketing around the Amphitheatre in Leonidoff's musical extravaganza, *Wonder World*. In Hollywood, I did the flying-belt sequences for the TV series, *Lost in Space*, and made several television commercials too. When I signed up to fly for Bell Aerosystems, I never thought they'd put me in show business, but it's been great fun.

All this flight experience established the Rocket Belt's feasibility.

(Continued on page 190)



Rocket Belt, first of family, kicks up spray as it's flown over water. Its hydrogen peroxide propellant produces lifting blast of steam.



Flying Chair—a sit-down, platform-type version of Rocket Belt—is tried out by the author. First free flight with it was made in 1965.



Материал, защищенный авторским правом

Defense Department reveals Jet Belt data

Just as this issue goes to press, **POPULAR SCIENCE** has obtained from the Defense Department the actual figures for the Jet Belt's remarkable performance—figures still classified when this article was written, but now cleared to be made public. They are:

RANGE: 10 miles	ENGINE THRUST: 430 pounds
SPEED: At least 60 m.p.h.	ENGINE WEIGHT: 68 pounds
TOTAL EMPTY WEIGHT , including engine, belt, and subsystems (fuel tanks, parachute, two-way radio system, etc.):	
126 pounds	
TOTAL FLYING WEIGHT , including operator and clothing (180 pounds), fuel and oil (43 pounds), and telemetry:	
365-367 pounds	
SPECIFIC FUEL CONSUMPTION (fuel consumed hourly, per pound of weight flown):	
0.70 pound	

THE EDITORS

Test-pilot Courter flies Pogo, stand-up version of rocket-borne platform. "Body-controlled" type shown, steered just by leaning, made debut in 1968.

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53

Gus Tricks a
Trickster

Latest adventures
of famous
auto mechanic
PAGE 198



Build Your Own

FLYING CART—NO WHEELS

—PAGE 161

Материал, защищенный авторским правом

Wheel-less vehicles with legs for walking, running, and jumping may be the tanks and jeeps of the future

**POPULAR
SCIENCE**
REG. U. S. PAT. OFF. Monthly



Now the Army is working on

Tanks That Walk and Jump

By Martin Mann

MAN'S greatest invention is the wheel, but this handy device isn't good enough for the U. S. Army. For the astonishing truth is that an Army design group is working on machines that walk, creep, run, and jump.

These strange vehicles have legs and feet like animals, and they *move* like animals. The first model of a machine that walks is now being tested. Others that borrow ideas from horses and grasshoppers have been designed.

The Army wants legged vehicles be-

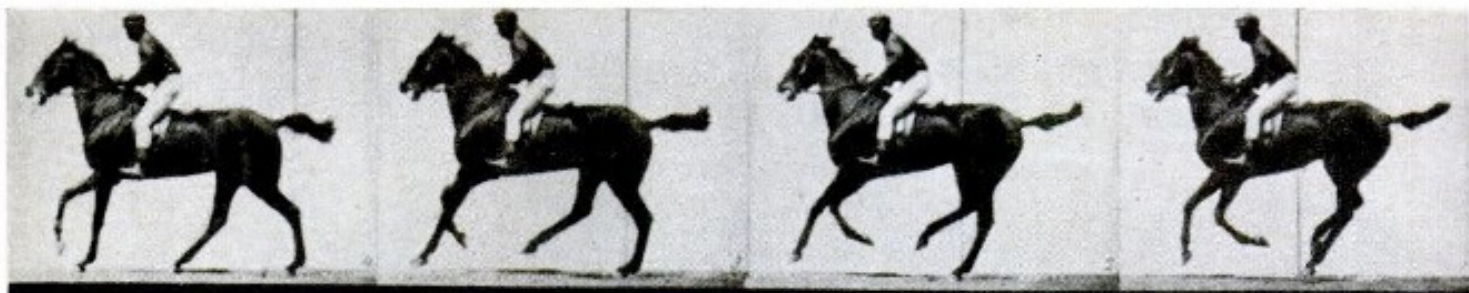
cause legs are still the fastest way to cross rough country. The humbling fact is that, while airplanes fly faster than birds and ships swim faster than fish, no ground-supported machine yet built can get over broken terrain as fast as a horse, mule, or donkey.

Perfecting such a machine might have revolutionary effects. Sportsmen, geologists, and surveyors might snap it up to get into rugged back country. Farmers might find it easier on their priceless soil than tractors. Miles upon miles of secondary roads, now maintained at great expense, might no longer be needed—

CONTINUED

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The horse runs with short, graceful leaps



Masterfully engineered for sustained speed, horse stretches its legs to go fast, folds them

with tax savings that are pleasant to dream about.

Military men say there is an urgent need for vehicles that can carry tank-like loads at animal-like speeds. Battles are rarely fought on roads, and great advantages come to the force that isn't tied to a road network. But tanks and jeeps are surprisingly slow once they get off the road. Even on fair terrain the best they can generally do is 10 m.p.h., and 5 m.p.h. is more common. Some rocky land and steep bluffs can't be managed at all.

Speedy animals. On a flat track, race horses have hit 38.7 m.p.h. over a mile. Speeds around 30 can be sustained on less-perfect surfaces for some distance. A wild ass has been clocked making an average 30 m.p.h. over 16 miles. An elephant that escaped from a circus camp in the mountains was found 10 hours later 130 miles away.

But more important, legs can go where wheels and track-layers can't. Mountain

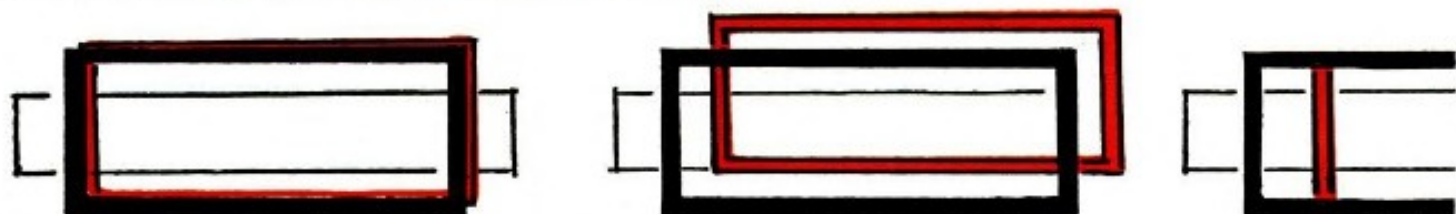
troops all over the world still rely on supply by mules. Kangaroos clear obstacles that would stop a tank.

If nature's designs, perfected over millions of years, are superior, we could be smart to copy them. So the Army hired university researchers to check out legs. There has been no breakthrough yet. But a two-foot-long platform *does* walk, and some of the weirdest mechanical designs ever conceived illustrate official papers.

Building a horse. Prof. R. K. Bernhard of Rutgers took on running and jumping. Both motions involve leaping, but running (as a horse does it) is a rhythmic series of leaps, whereas jumping (as a grasshopper does it) is made up of individual, nonrhythmic leaps. Professor Bernhard designed fantastic contraptions to imitate each animal.

The mechanical horse could be jounced along by a motor swinging eccentric weights. This would make the vehicle bounce rhythmically along the ground.

Army's walking machine plods along

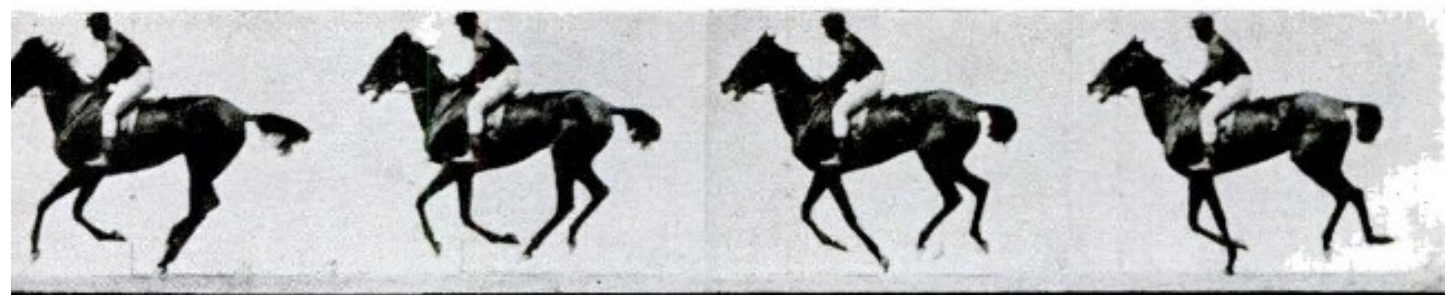


Clumsy gait of model walker is indicated in these diagrams, which follow movement of two

Jumping machine was to hop like a grasshopper



Levers modeled after animal legs could jump vehicle across the ground. But shocks of



short to lessen inertial force. Photos are from Muybridge's famous series, shot in 1870s.

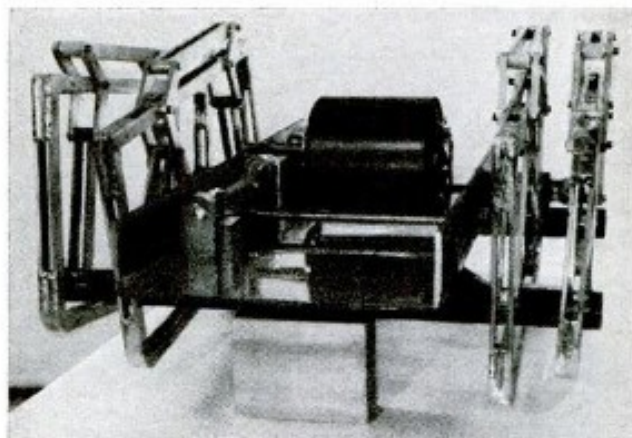
Power unit and crew would ride a softly sprung platform. Unfortunately, the horse machine couldn't hurdle large obstacles. And it couldn't run very fast.

The grasshopper machine. Professor Bernhard's proposal for a man-carrying grasshopper was stranger yet. It was to leap by means of a power-operated pogo stick. This would be an adaptation of a commercial machine called a rammer, used to compact soil in construction work. It has a one-cylinder engine with a tamper fastened to the piston rod.

Professor Bernhard planned to equip a frame with rammers set at an angle, their piston rods linked through levers (equivalent to thigh and leg bones) to pronged "feet." When the rammers fired, the levers would extend to propel the machine up and forward, exactly like a grasshopper. The machine would land on big air bags to cushion the shock.

The grasshopper machine could go fast (maybe 30 m.p.h.) and jump obsta-

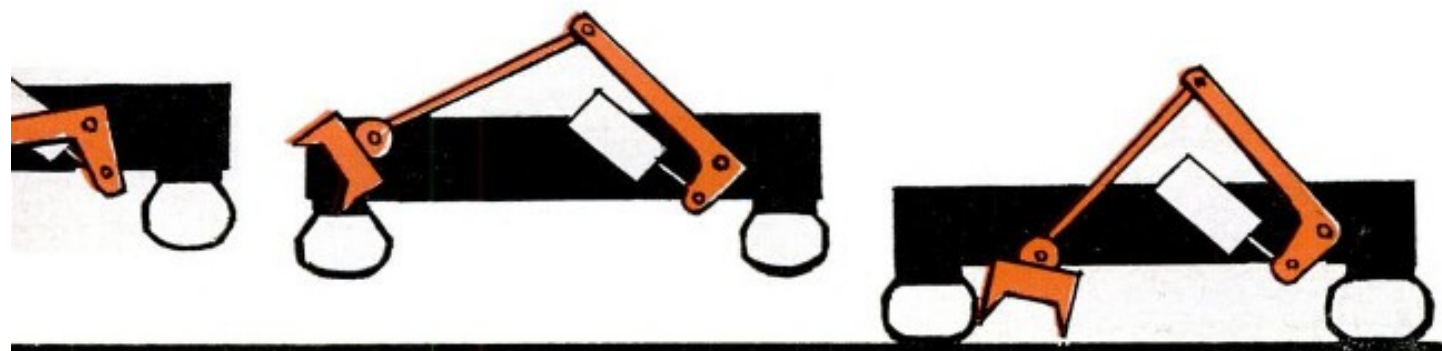
cles. But it couldn't back up easily and might spill if it landed on a rock. More important, the shocks of takeoff and landing threatened to pulverize a crew, and maybe the machine as well. Impact absorption is a major problem; on certain kinds of rough going, a jeep can take



THIS CONTRAPTION WALKS: Complicated linkages move the four legs (open metal rectangles) of working model of Army's walking machine. Motor cranks levers through egg-shaped gears.

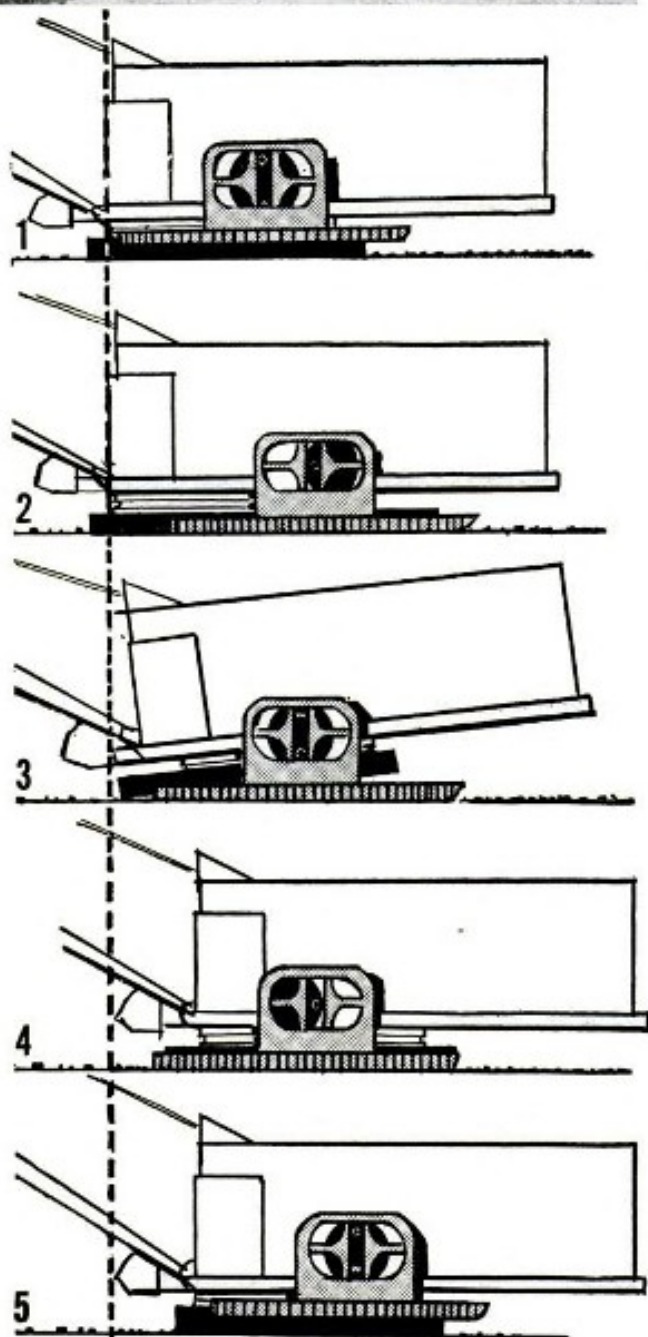


legs on one side of the body. Action is inefficient, but might achieve 20-m.p.h. speed.

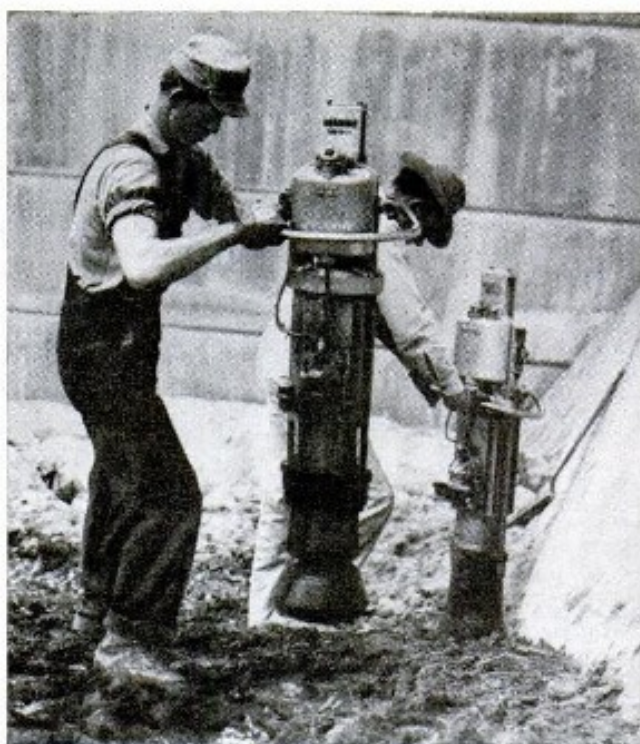


takeoff and landing would be too great for a machine large enough to carry men, weapons.

These leg-propelled machines are already in use



WALKING DRAGLINE, Bucyrus-Erie's huge excavating machine, hitches itself across ground on long feet. It goes backwards only (see sketches). At work (1), feet are off ground, dragline resting on central baseplate. Rotating cam moves feet to right and down (2), tilts body (3), slides body to right and down (4), lifts feet again (5). The monster's top speed: $\frac{1}{2}$ m.p.h.

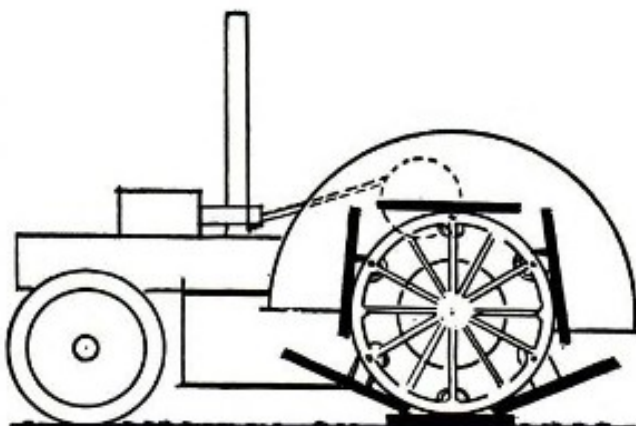


RAMMER, Barco's hopping dirt-tamper, has wide foot fixed to piston rod of a one-lung engine. It jumps 14 inches, 60 times per minute. When tilted, it hops along like a pogo stick.

bumps that human passengers cannot.

A 20-m.p.h. walk. After Professor Bernhard filed his report (no models were built), the Army pulled in its reins and decided to try walking before running and jumping. This assignment went to the University of Michigan's Prof. Joseph E. Shigley. He hit upon a contraption that looked as if it might walk: a shuttle linkage used for conveyors. He turned this gizmo upside down and drove it through egg-shaped gears cunningly calculated to eliminate sudden accelera-

[Continued on page 216]



FEET—hinged to wheels, not to legs—propelled this steam tractor invented by Boydell. It was an excellent cross-country vehicle, widely used until the caterpillar tractor replaced it.

PS PICTURE NEWS

Wheeled stadium provides view for two sports

Part of the new baseball-football stadium to be completed next year in Washington, D. C., will roll on wheels.

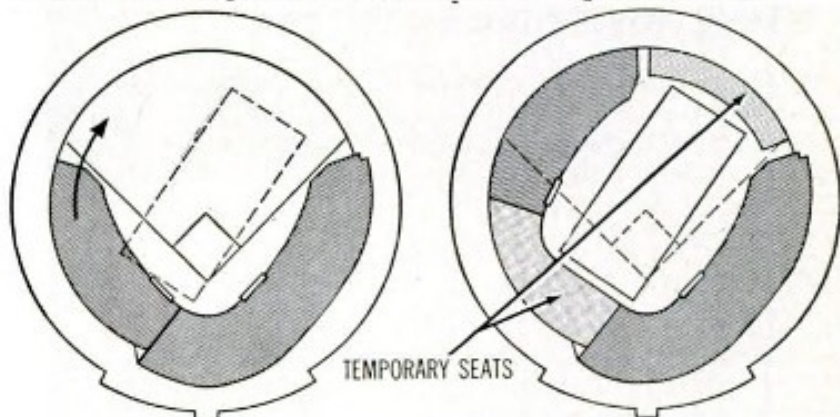
One 400-foot lower grandstand section, including a built-in dugout, will rest on 83 steel wheels 24 inches in diameter. It will reach from the first-base line at home plate to the left-field foul line.

At the close of the baseball season, the section will be pulled by tractors on two tracks—one bolted to the stadium wall, the other buried underground in the outfield. Gaps at the two ends will be filled with temporary seats.

The rolling stadium is being constructed by Osborn Engineering Co., Cleveland, builders of big stadiums: Yankee, Cleveland, Milwaukee, U. of Michigan, among others. It will seat 42,000 fans for the 1961 baseball season, 52,000 Redskin followers that fall.



Model of rolling stadium with seats set up for baseball.



Section rolls clockwise for football games.

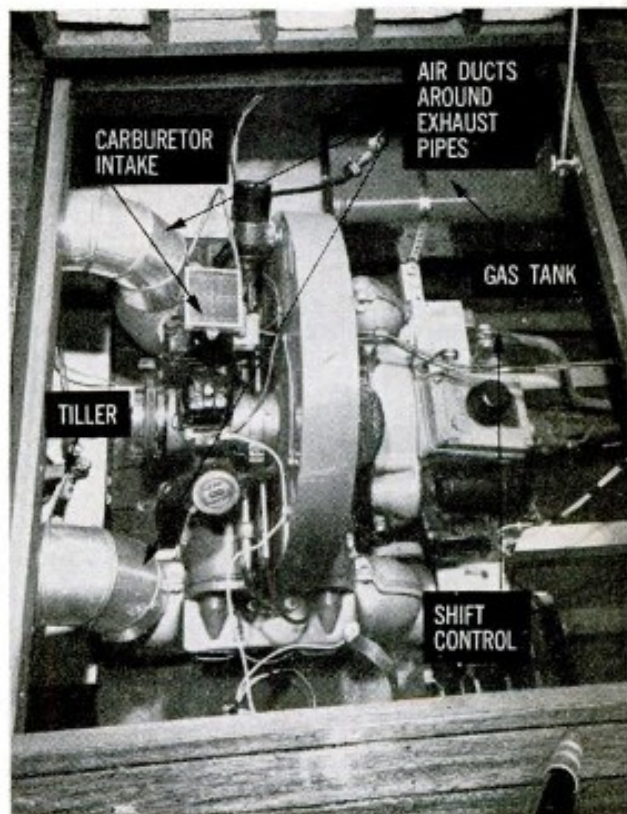
Runabout uses VW engine



Built especially for the Volkswagen engine, a 17-foot inboard runabout hits speeds up to 25 m.p.h. The Volks-Liner's one-piece hull is made by a German process developed for small planes. It consists of thin birch strips impregnated with a plastic and laminated into five layers.

The 36-hp. VW engine turns the propeller through a Walter's marine V drive with built-in 1.29:1 reduction gear. Air to cool engine, transmission, V drive, and exhausts is drawn into the engine compartment through an opening under the rear seat. It's blown out through the transom in large ducts that encircle the engine exhaust pipes. Fuel consumption is about 1.8 gallons an hour, giving the boat a six-hour cruising range on one tank of gas.

Volkswagen auto dealers will sell the boat for \$2,495 f.o.b. Dundee, N. Y.



Engine turns prop through V drive.

Mechanical Crab

to Search Ocean Depths

With an arm 2,000 feet long, TV-camera eyes, and a claw that can clamp onto a 2½-ton load, the giant robot Solaris is a treasure-hunter's dream come true

By Devon Francis
DRAWINGS BY BOB McCALL



WORKING MODEL in photo above shows propellers for maneuvering, claw for grasping, and octopus-like body that houses electric motor to power both. Prototype will descend 650 feet, far deeper than human divers; later versions of Solaris will go down into the ocean as deep as two-fifths of a mile.

SOMETIME late this fall, a U.S. Navy boat in Puget Sound will drop overside, on a couple of cables, one of the strangest contraptions ever lowered to the ocean's depths. On its top will be a brace of propellers, at its middle a sphere, at one side a television camera flanked by lights, and on its bottom a claw.

The thing will be called Solaris. It will be the underwater treasure-hunter's dream come true.

Imagine sitting high and dry on the deck of a boat, and having at your command an arm more than 2,000 feet long to pick up whatever suited your fancy from the ocean floor—plus eyes to scan thousands of square yards of it.

Now under construction in Silver Spring, Md., for experimental torpedo recovery for the Navy, Solaris will be unmanned. In prototype, it is designed to descend to 650 feet, but it can be adapted to go down as far as two-fifths of a mile. That's 1,750 feet below the average safe working depth of a human diver.

Solaris is designed to do everything that a human diver can do, and more.

The propellers are for maneuvering. The sphere is the power unit. The TV camera gives underwater eyes to an operator aboard the launching ship. The claw is for retrieving anything that the operator wants on the ocean bottom—including sunken treasure.

Solaris (Submerged Object Locating and Retrieving/Identification System) is versatile. It can go exploring, covering 1,400,000 square yards of ocean floor at a depth of 2,000 feet.

It can perform such prosaic tasks as inspecting channel bottoms, ship keels, bridge pilings, and submarine cables. It can clamp and bring to the surface objects weigh-

CONTINUED

PAINTING IN FOLDOUT AT RIGHT depicts Solaris at work salvaging a wrecked plane—one of its many possible missions. See reverse side of foldout for Solaris' various components and how the huge robot will be controlled from operator's console on the surface.

ing as much as 2½ tons. It can place explosive charges, and then back off and detonate them.

One of its possible uses is recovery of pieces of rockets fired from Cape Canaveral and destroyed in flight because of deviation from course. Skin divers have to do this now.

The Vitro Corp., which is building Solaris to specifications outlined by Jack Green, project engineer at the Naval Torpedo Station, Keyport, Wash., knows it can perform all these duties because a preceding device already has demonstrated it. What might be called the daddy of Solaris was developed, also, for the Navy. Its missions are classified.

One of the two cables is the lifeline of the snoop Solaris. This cable lets it down and pulls it up. Solaris' second cable is its nervous system. Through this, the operator topside issues commands for the thing to crawfish this way and that, to rise a bit or descend, to clamp onto a prize, to drive studs into steel plating, or to plant explosives.

The second cable also carries current for lights that illuminate the inky reaches of the deep, and it transmits the TV signals to a screen so the operator can see what he's doing.

Sitting at a console, the operator taps the second cable for information on heading, depth, height above bottom, propeller r.p.m., amount of illumination, and what Solaris' claws (or one of its substitute fitments) are up to.

That second cable, carrying the electrical lines, must be strong enough to take some tension, yet flexible enough to bend and twist while the vehicle is scrounging around on its boggle-eyed missions.

The sphere (a sort of octopus body inside Solaris' working ganglia) houses a 10-horsepower electric motor. It turns a hydraulic pump that supplies power not only for propulsion but also for the claw. To keep everything shipshape, the watertight sphere contains a leak detector and depth-measuring sonar.

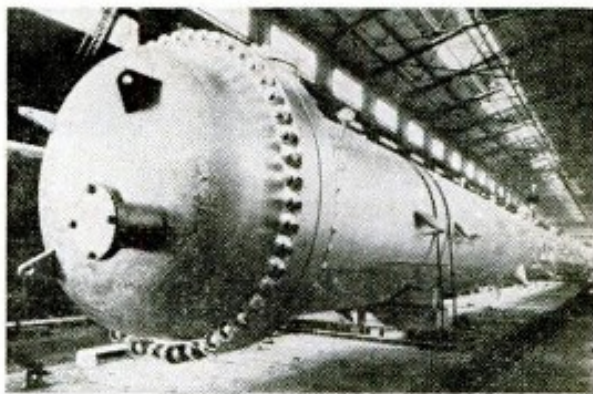
How it works. To maneuver the vehicle, the operator has only to turn on the propellers and vary their speed. They are driven hydraulically through gearing that is essentially like an automobile differential.

[Continued on page 218]



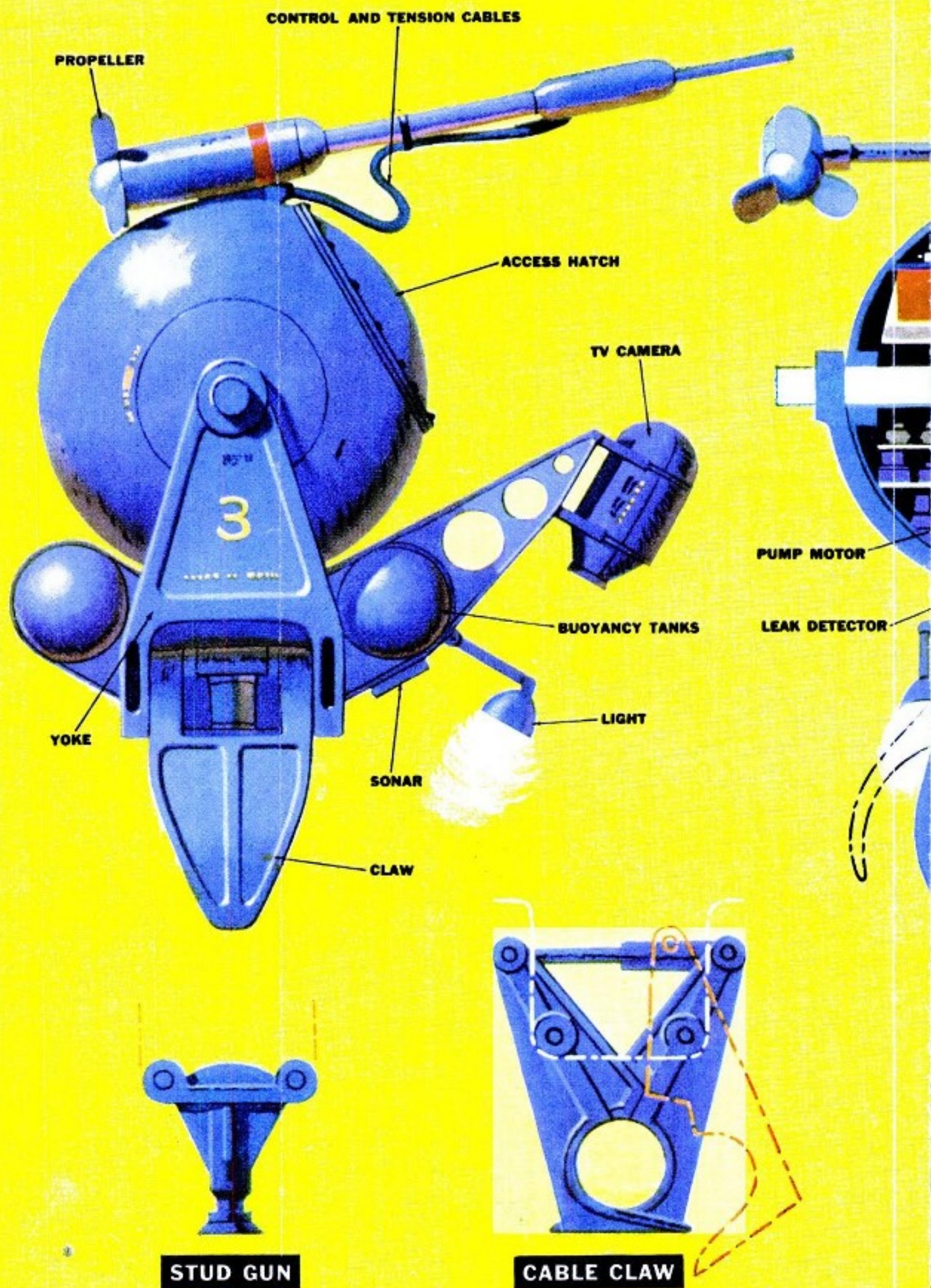
Phone plays back messages

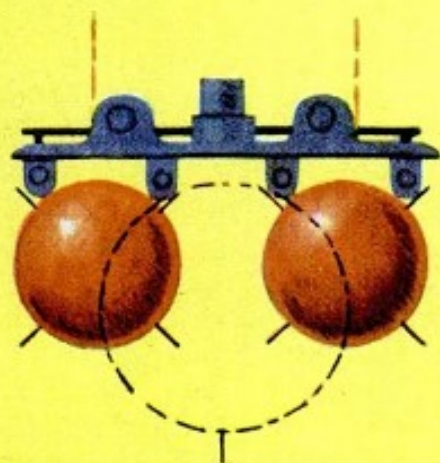
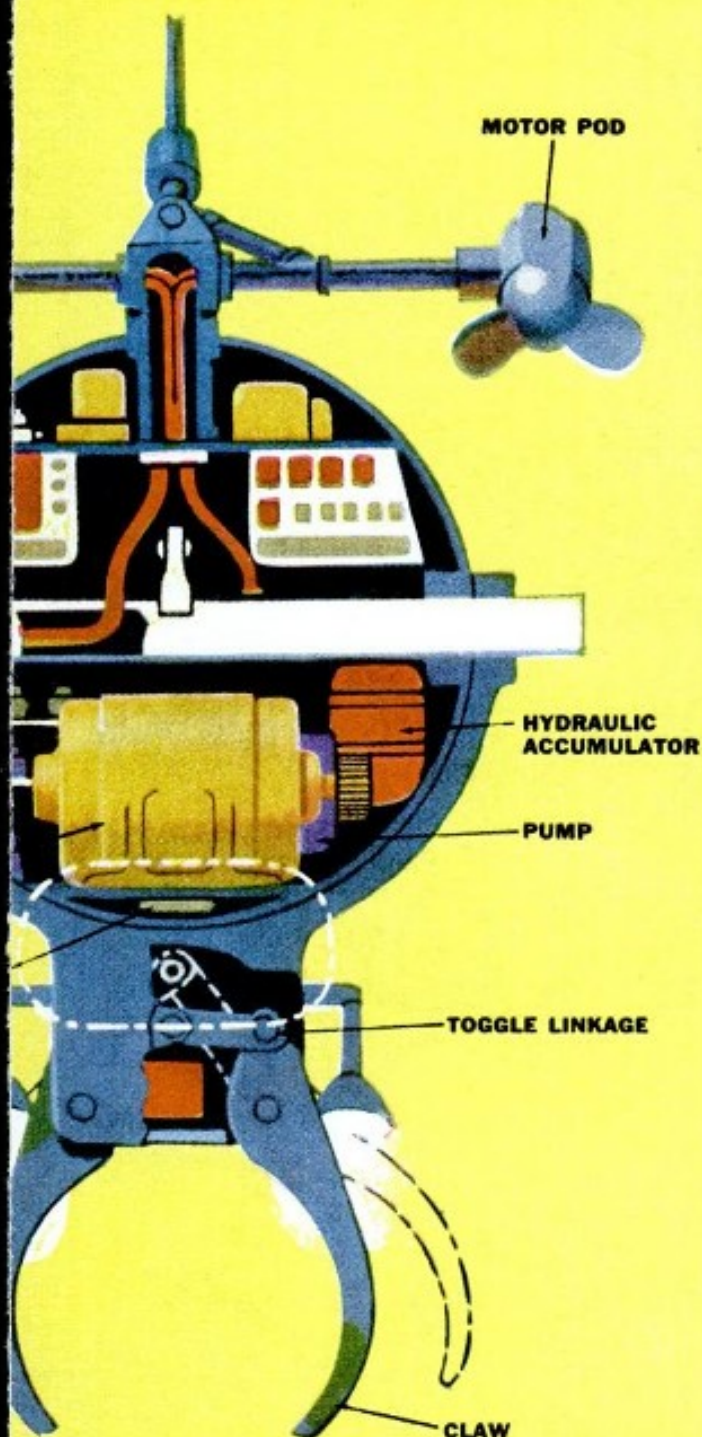
Here's a Hungarian telephone that not only records messages but plays them back if the subscriber calls from another phone—but only when he gives a code signal. The secret triggering is done with a slot in the prerecorded tape that instructs a caller to leave his message. When the subscriber utters a sound at the right point in this statement, the playback mechanism is actuated. The tape won't respond to a constant sound. It clams up completely if a would-be eavesdropper calls and makes two wrong guesses, even if his timing is correct on a third try.



Turns ore to iron

Dispensing with a blast furnace, this huge 122-foot pressure cooker will extract iron directly from the ore. Upended, it will use hydrogen gas at high pressure and temperature to reduce the iron-oxide ore to metal—the way carbon monoxide, from burning coke, does in a blast furnace. Riding across country on a string of railroad flatcars, the 238-ton vessel is shown on its way to Bethlehem Steel's Los Angeles plant, to apply the new process.

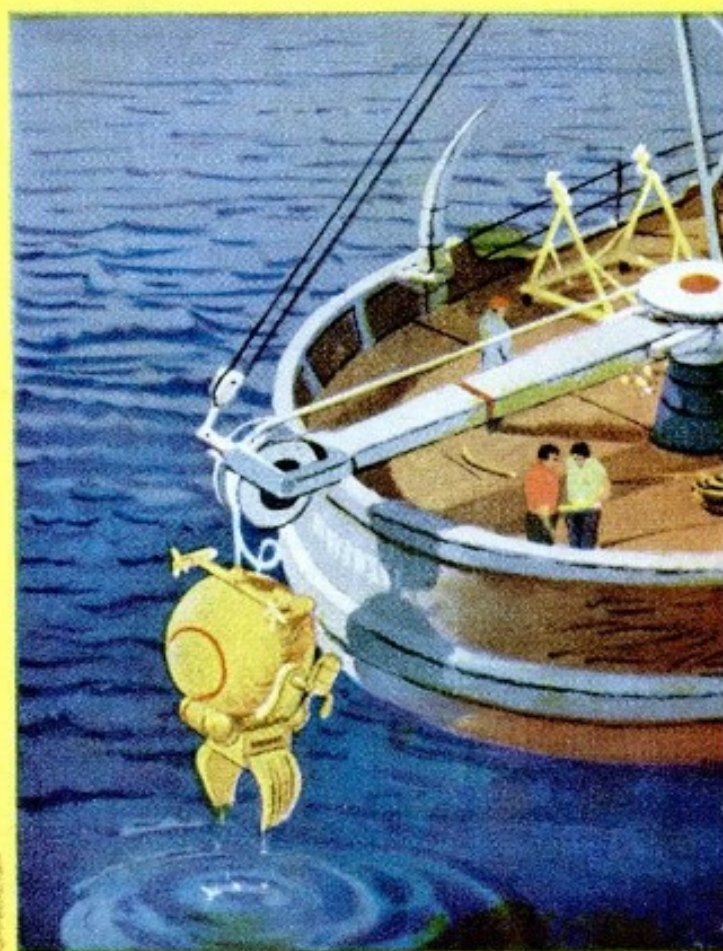




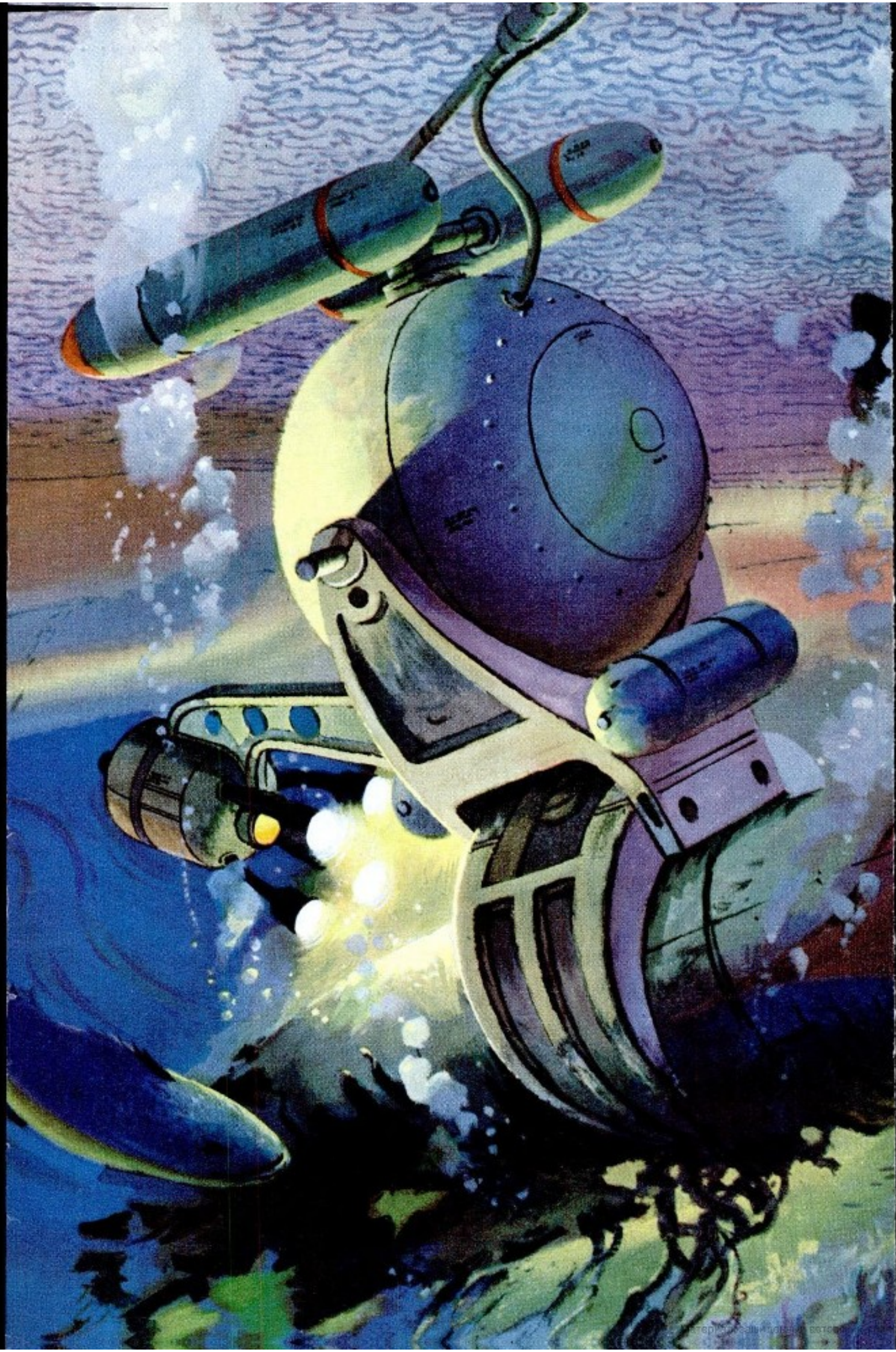
EXPLOSIVE-CHARGE ATTACHMENT

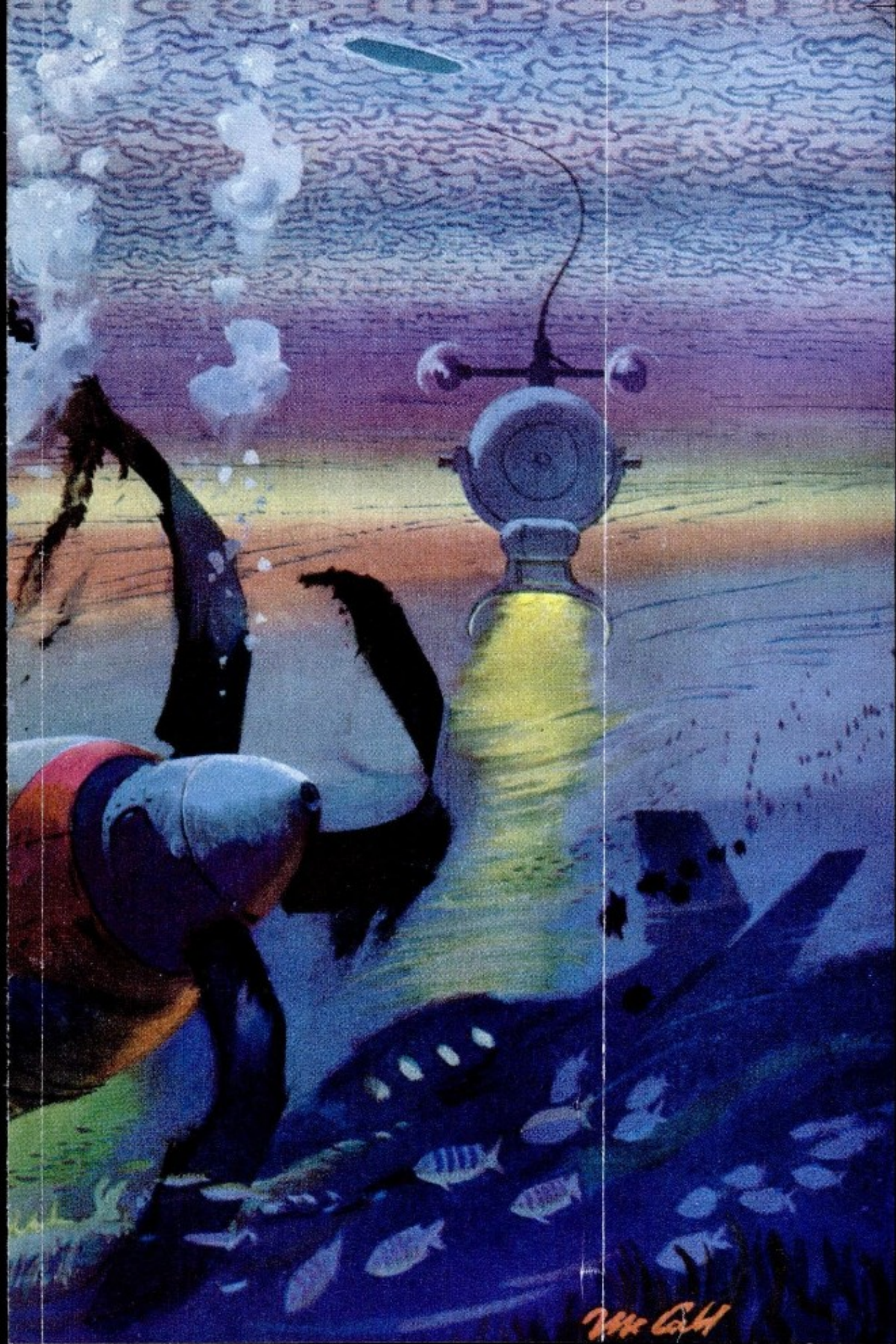


CONSOLE ON SHIP has controls for maneuvering and claw movements. Operator uses TV image for manipulations. Instruments show vehicle heading, depth, height above bottom, claw position, propeller r.p.m., light intensity, cable paid out, and power supply.

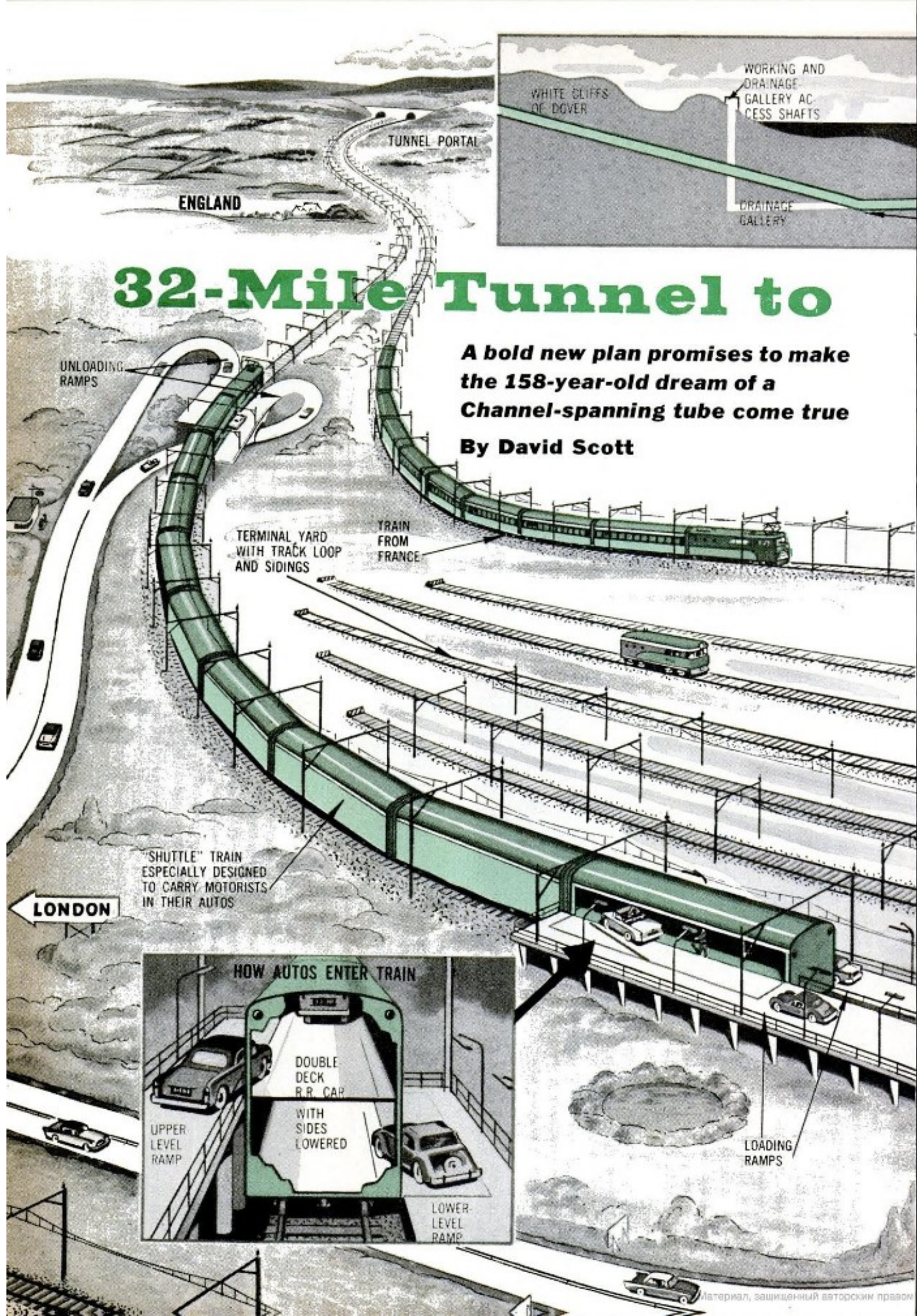


LOWERED INTO WATER, Solaris is supported by cable from one drum, while electrical cable, to minimize strain on it, unreels from another. The two cables are automatically laced together by nylon cord as vehicle descends. Unlaced as they are winched back.





Mike Cohn



ENGLAND

TUNNEL PORTAL

32-Mile Tunnel to

A bold new plan promises to make the 158-year-old dream of a Channel-spanning tube come true

By David Scott

UNLOADING
RAMPS

TERMINAL YARD
WITH TRACK LOOP
AND SIDINGS

TRAIN
FROM
FRANCE

LONDON

"SHUTTLE" TRAIN
ESPECIALLY DESIGNED
TO CARRY MOTORISTS
IN THEIR AUTOS

HOW AUTOS ENTER TRAIN

DOUBLE
DECK
R.R. CAR
WITH
SIDES
LOWERED

UPPER
LEVEL
RAMP

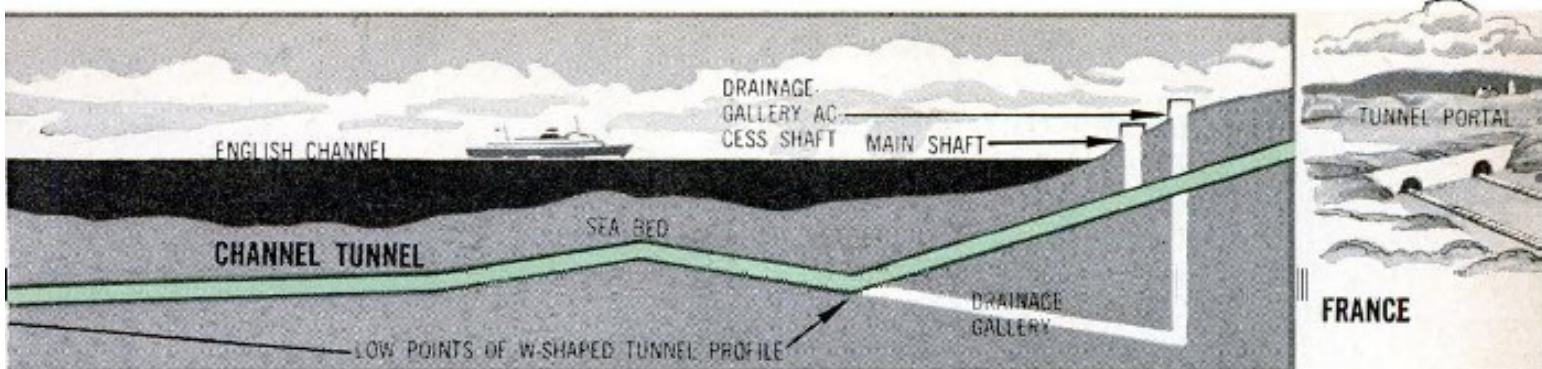
LOWER
LEVEL
RAMP

LOADING
RAMPS

WORKING AND
DRAINAGE
GALLERY AC-
CESS SHAFTS

WHITE CLIFFS
OF DOVER

DRAINAGE
GALLERY



Connect England and France

FROM a ramp, you drive right into a railway car at the rear of an electric train, standing at a terminal near Folkestone, England. You pilot your auto forward through the cavernous interior of the train—its cars are joined by platforms to make a continuous runway—and stop behind the next-earlier arrival. Other autos draw up behind you. Then the train starts, speeds nine miles above ground, and plunges into the most remarkable tunnel in the world.

Still sitting in your automobile, you are borne for 23 miles beneath the waters of the English Channel, at an average speed of 60 m.p.h. In less than 45 minutes, the train rolls to a stop. Motorists restart their engines, and you drive off the front of the train to find yourself in France. As you disembark at the French terminal near Calais, you see another line of autos about to board the

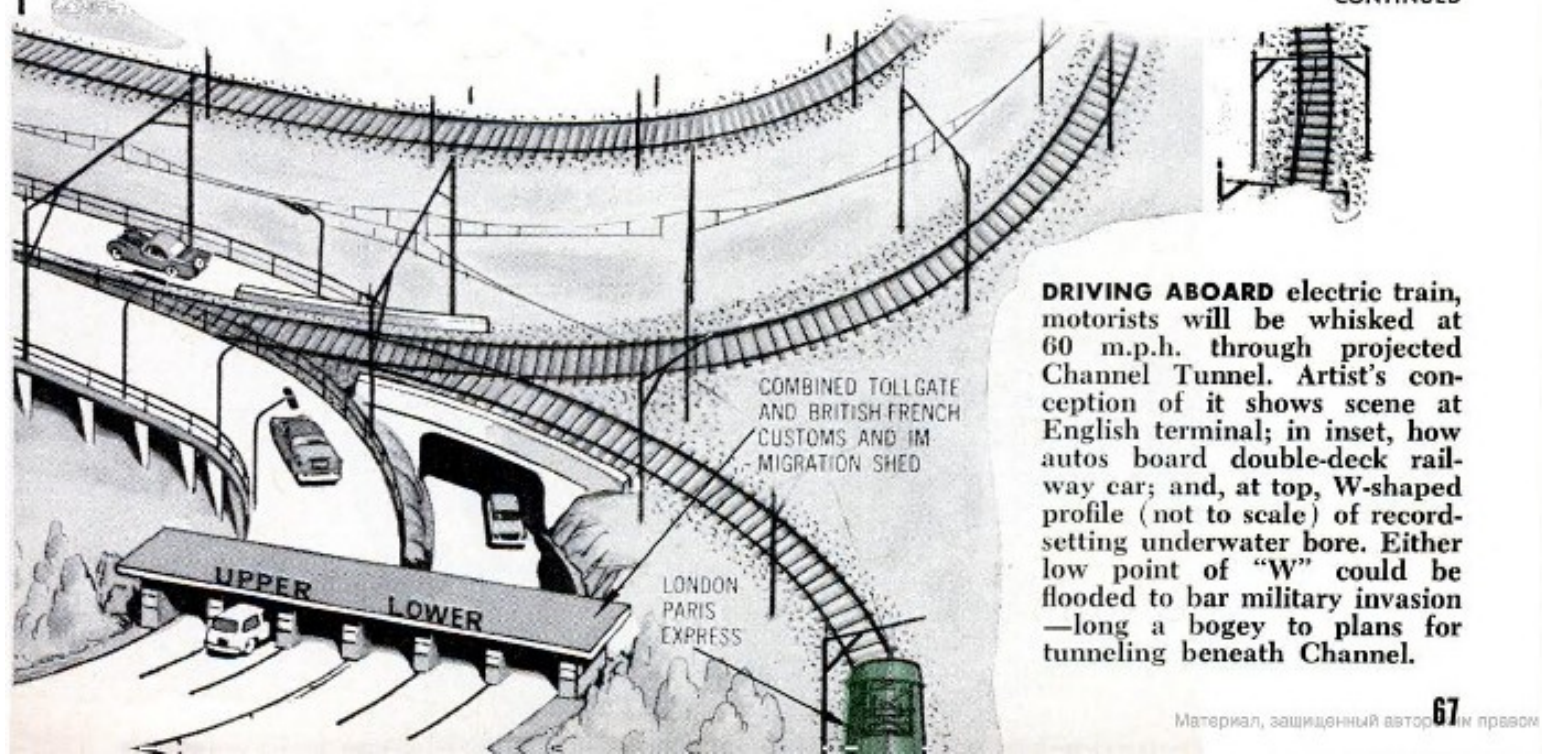
train for its return trip to England.

That is a preview of high-speed, all-weather, comfortable, and inexpensive travel between England and France by 1967, if a startling plan to drive a tunnel beneath the Channel goes through.

At 32 miles from portal to portal, it would be the world's longest passenger tunnel by so far as to be in a class by itself. It would dwarf the Alps' famed 12-mile Simplon rail tunnel, and the seven-mile vehicular tube under construction through Mont Blanc, the present and prospective record holders of their kinds. Its cost would exceed the \$300,000,000 value of the British crown jewels. Like the Great Pyramid of Egypt and the Panama Canal, the proposed Channel Tunnel would rank among the engineering wonders of all time.

Latest of many schemes to link Britain and France by tube or bridge, this mod-

CONTINUED



Train-carrying tubes are to be bored full-size by giant

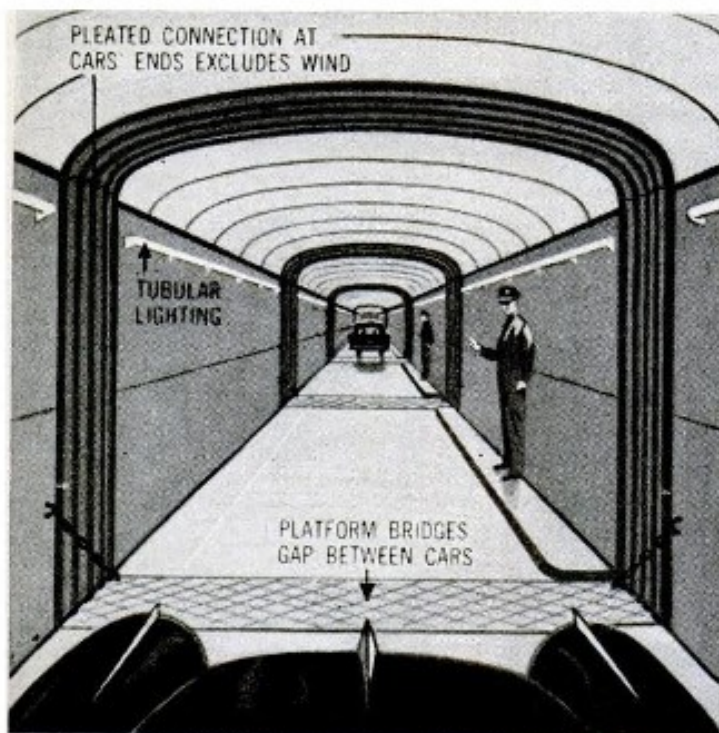
ernized plan brings the 158-year-old dream nearer realization than ever before. Calling for a twin-tube rail tunnel, it is sponsored by influential English-French-American interests collectively known as the Channel Tunnel Study Group. With encouragement from high places, they recently submitted their proposal to the British and French Governments, upon whose approval its fate now hangs.

The plan envisages two main tubes running side by side, 97 feet apart, between portals near Dover in England and Calais in France. Bored through the Channel bed, they dip 100 to 200 feet below the sea floor. Each circular tube has an inside diameter of 21 feet 4 inches and holds a single railway track.

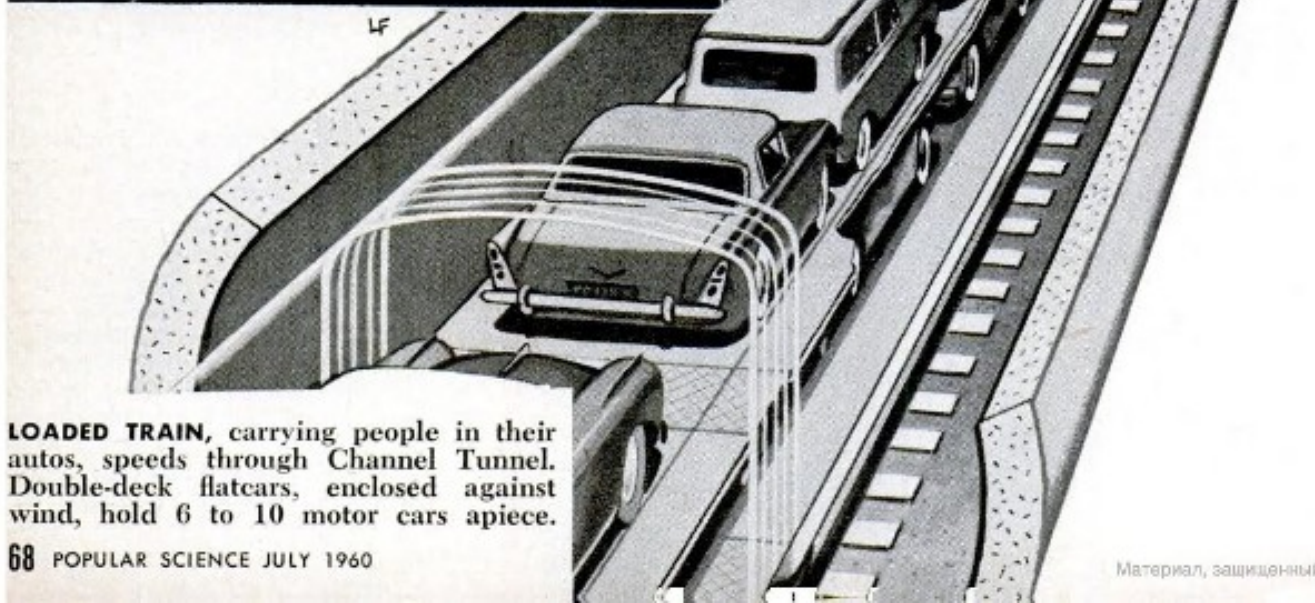
Shuttle trains, especially designed to

carry motorists in their autos, run through the tunnel at 15-minute intervals, plying the 44-mile distance between the terminals beyond its portals. A loop of track at each terminal turns the train around for the return trip.

While single-deck flatcars may serve at first, the final plan is for double-deckers, enclosed to reduce air drag and shield passengers from wind. Each holds six to ten autos, according to their size. Made up of perhaps 30 cars, the train is loaded at the rear and unloaded at the front, through special drop-sided cars, at two-level ramps. To streamline international formalities, a joint British-French customs and immigration shed is combined with the tollgate spanning the approach to the loading ramps.



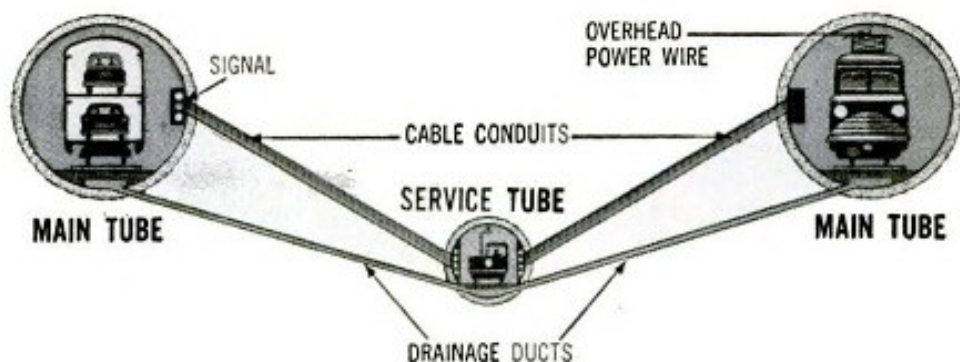
INTERIOR of auto-carrying shuttle train will look like this to motorist as he drives forward through it to take his place in line for trip under Channel.



LOADED TRAIN, carrying people in their autos, speeds through Channel Tunnel. Double-deck flatcars, enclosed against wind, hold 6 to 10 motor cars apiece.

rotary machines

EACH MAIN TUBE, shown in sectional view of Channel Tunnel, has inside diameter of 21 feet 4 inches and carries electric trains in one direction. Smaller service tube below them provides for drainage and maintenance.



Through passenger and freight trains use the tunnel, too. Express-train passengers speed from the center of London to the center of Paris, via the tunnel, in only 4 hours and 20 minutes.

Each main tube normally carries trains one way. But trains can be shunted from one tube to the other at four crossovers—one at each coast, the others seven miles offshore. Thus a section of either tube can be closed off for repairs or maintenance. At night, when this would be done, trains running back and forth through one tube could handle the light traffic.

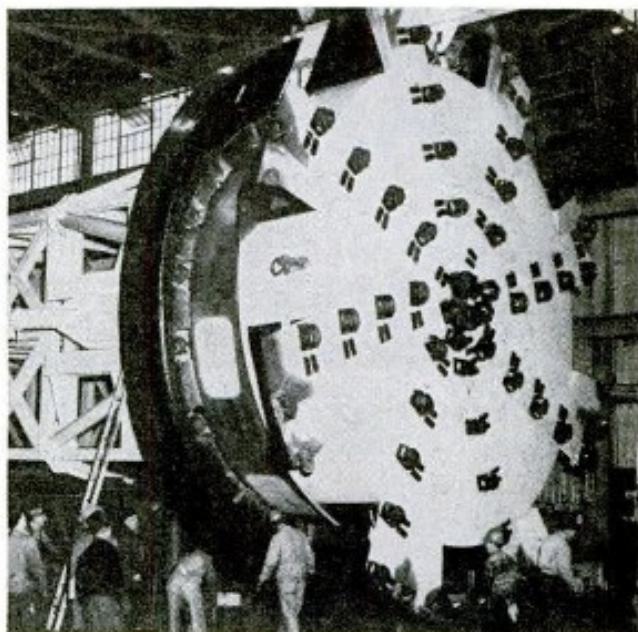
Between and below the main tubes, a service tube about 11 feet across serves for draining them, for maintenance, and as an electric-cable conduit. Cross passages connect it with the others. The service tube slopes downward from mid-Channel to the bottoms of vertical access shafts on each coast. These house elevators, ventilating ducts, and pipes for pumping out seeping water.

Fresh air. Since the tunnel is used by electric trains, rather than by motor vehicles gulping air and belching exhaust fumes, ventilation is no problem. Engineers anticipate that the trains themselves, like pistons in cylinders, will aid in circulating fresh air through the long underwater section.

As novel as the rail tunnel itself is the scheme for excavating it. A giant rotary machine with a 23-foot 10-inch cutting head will literally bore the full-size tube through the Channel bed.

It will eat through a kind of rock ideal for tunneling. As if put there by providence, a 1½-mile strip of firm chalk lines the Channel at its narrowest point. All but impermeable to water, strong enough to need no support after being bored, it still is soft enough to yield easily to a

[Continued on page 213]



HUGE ROCK BORER like this mechanical mole, used at Oahe Dam in South Dakota, is expected to drive 23-foot-diameter hole for Channel rail tubes at the rate of 1,475 feet a month.



ACTUAL START on Channel Tunnel, in 1880s, produced seven-foot-diameter tube shown in this historic British Railways photo. Early boring machine, ancestor of big modern ones, drove it more than a mile from English side.



BANANA HAULER can skim over jungle trails and streams at 12-inch altitude. Estimated top

speed: 40 m.p.h. It will carry three men plus cargo, making a total load of about one ton.

Banana truck rides on bubble of air

Hauling bananas in the Southern Cameroons is a problem: bad roads, unreliable rivers, and a cargo that bruises easily. So Elders and Fyffes, Ltd., who own plantations there, ordered a truck-without-wheels to float their fruit out of the jungle on a bubble of air.

The first model (above) gets its air bubble in a way that may lead to cheaper, more effective wheel-less vehicles. Instead of a central fan blowing air through costly ducts to the edge of the body, it

has fan blades at the edge to push air straight down, as shown in the drawing on the facing page. The fan has no hub—just two concentric rings connected by blades. The rings, riding on rollers, are spun by a friction drive. The outer ring is so large (about 18 feet in diameter) that its edge spins at 240 m.p.h.

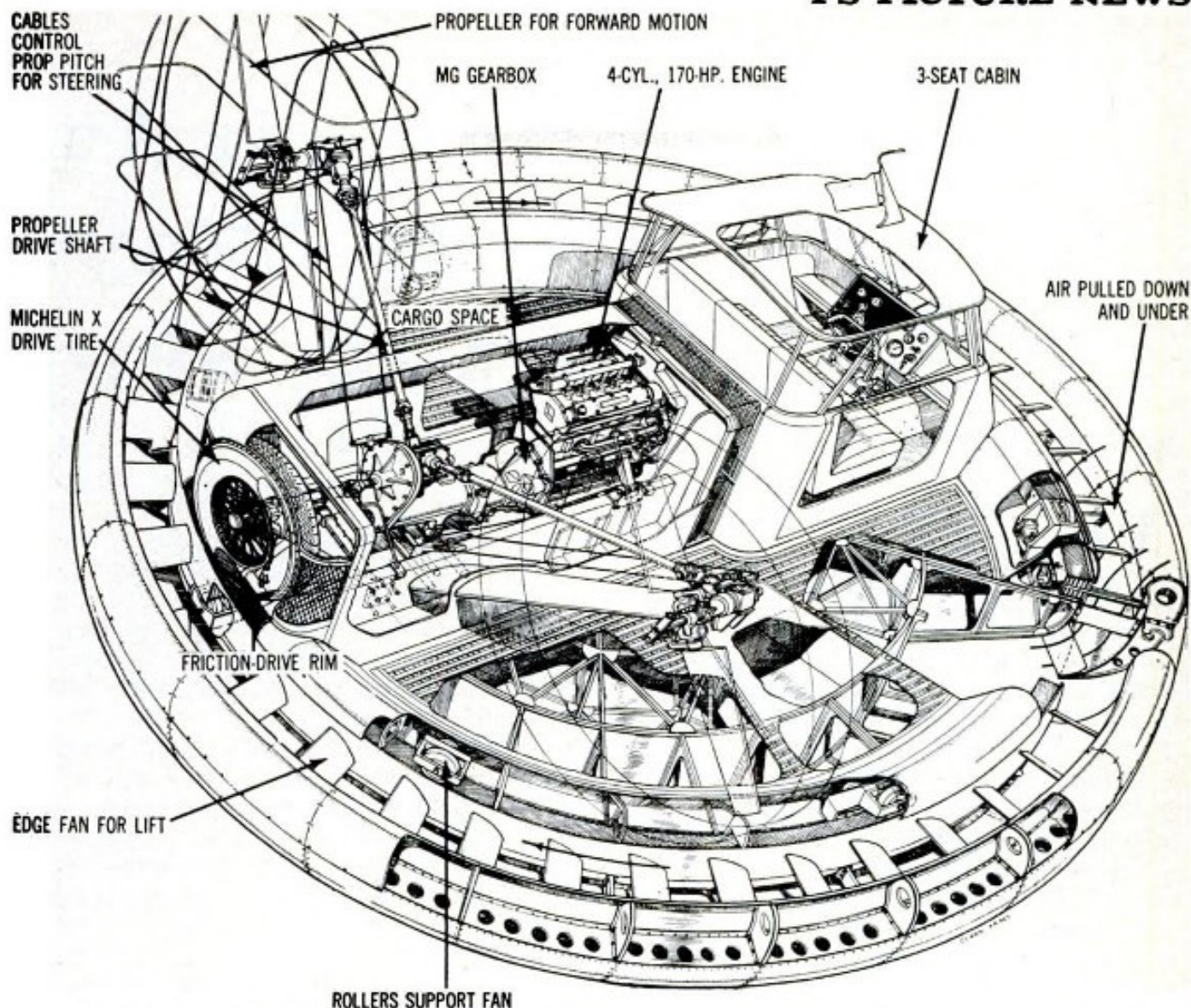
The same engine that spins the fan also powers two propellers to scoot the Cushioncraft forward. Britten-Norman, Ltd., of Britain, built it.



Solar generator to circle earth

A 1,500-watt solar generator will furnish power for space satellites by converting energy from the sun into electricity.

It will contain about 7,000 four-inch aluminum reflectors like those in the six-bank test model at left. They will concentrate sunlight on collectors in their centers, producing heat of 1,000 degrees at the hot end of a thermocouple. Hamilton Standard is building it for the Air Force. For ground-testing, a 100-watt, 900-reflector model will be made first.



TRICKY DRIVE SYSTEM is shown in cutaway from British journal, *The Aeroplane*. Car wheel, spun

by a sports-car engine, presses against rim of the fan to turn it. The fan rides on rollers.



ODD LANDING GEAR on the Canadian Otter was devised to simulate a tricycle gear cheaply.

Four-wheel landing gear

Canada's de Havilland Otter, already noted for short takeoffs and landings, has become even more STOL after a four-year guinea-pig stint. As shown above, it has been fitted with big and



FLAPS DOWN, the Otter makes a low-level flight over an airfield at a slow 42 m.p.h.

powerful wing flaps and a new tail that rides high. The angled horizontal "butterfly" tail surfaces allow the airplane to clear air swirls set up by the big flaps. The unusual landing gear—substitute for costly tricycle gear—gives good air flow over the tail for control on the ground.

Plain Facts on Fallout Shelters

POPULAR SCIENCE

DECEMBER • 35¢ Monthly

This Car Goes Anywhere

with
Two Engines,
Six Wheels,
Boat Body



**Special Save-It
Section:** **All About Making Tables**

Материал, защищенный авторским правом

This Car Goes Anywhere

By Hubert Lockett

PS PHOTOS BY R. D. BORST

***Neither snow, nor swamps, nor hills, nor
rivers can keep you from your appointment
with the wilderness in this backwoods buggy***

POWERED by twin chain-saw engines, this fiber-glass cross-country kart covers water, swamp, or rocky hillside with the reckless ease of a well-trained retriever going after a downed mallard. It'll scramble up a 45-degree slope that would leave a mountain goat breathless, or do

CONTINUED

This six-wheel, gasoline-burning steed takes you



BIGGEST SURPRISE was the Jiger's relatively soft ride. I had expected something more like the teeth-chattering ride of its distant cousin, the racing kart. Learning to drive it is easier than it looks. I took over in an open field where my mistakes wouldn't hurt. At first, things happened more suddenly than I wanted. But I soon gained confidence and was roaring across the countryside.



30 miles an hour across a meadow. On water, it will purr along at six to eight.

Plans call for the Jiger to be in production within the next four or five months. John Gower, the designer and president of JGR Gunsport, Ltd., the concern that will manufacture it, says they already have enough orders to take the first year's production. The price is \$895 f.o.b. the plant in Toronto, Canada.

I drove one of the handmade, pre-production Jigers. Although it was designed primarily to meet the needs of hunters and fishermen, I can report that

.....
For details on a soft-tire car you can make yourself, see page 138.
.....

it is likely to deal those sports a low blow. Racing cross-country in a Jiger is so much fun you are likely to forget all about your gun or rod.

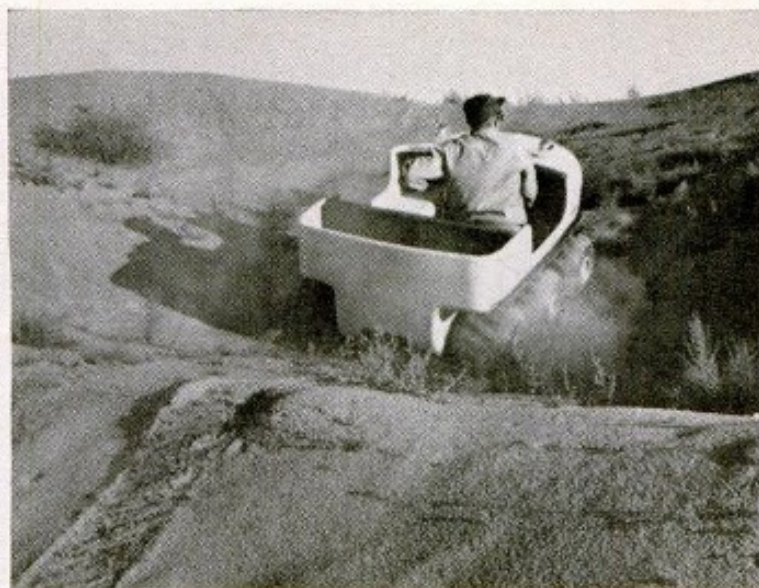
Every change in terrain, any stream, gully, or hillock that catches your eye is a challenge. You quickly learn that it will take most obstacles in stride and you cast around for sterner trials.

A 45-degree embankment? The footing is loose gravel and dirt, strewn with dead tree limbs and large rocks. You pause at the bottom and wonder if you're not carrying your foolish quest a little too far. Screwing up your courage, you twist the handle-grip throttle. The idle snuffling of the chain-saw engines becomes a nervous chatter. You lurch forward as the automatic clutches engage.



JIGER'S JOURNEY STARTS where the highways end. It's easier to trailer than most boats, or you can carry it atop a station wagon. Two men can easily handle its 200 pounds. It will carry 450-pound payload uphill or across a lake. If you

about any place a four-legged oat-burner could



manage to get it stuck or want to take it with you to places you don't care to ride, you can drive it from outside with only one hand on the control stick. You have double security on water. If you knock a hole in the hull, the tires

provide enough flotation to keep you from sinking. If all tires should go flat, displacement of the hull is enough to keep you afloat. On level ground, you can streak across country at a top speed of 30 m.p.h.

FEBRUARY 1965 35 CENTS

Popular Science

Monthly



**TINY
TV SETS
ARE "IN"**
A Buyer's Guide

LBJ's HEART
What the medics
have learned
about his —
and yours

**RACE CARS
of the WORLD**
—a complete
spec chart

**WHICH
COMPACT
FOR YOU?**
PS test-drives
Falcon, American,
Valiant, Chevy II

**24
PAGES
ON BOATS,
HULLS, DOCKS,
ETC., ETC.**

recharging takes 10 hours. The battery can be recharged approximately 50 times before it's worn out. A battery replacement costs about \$11; that works out to about six cents a viewing hour.

The Delmonico and Sony four-inch sets can also be powered by nonrechargeable flashlight cells; cost per viewing hour is much higher—about 40 cents.

Special interference-killing circuitry and a wide array of accessory mounting brackets and connecting cords let you watch them in moving cars (from the back seat, of course) and boats.

Their small screens—ranging from a snapshot-tiny four inches to a magazine-size nine inches—are perfect for close-range personal viewing.

You'll be surprised how quickly you get used to a small screen. One reason is that you can't see the scanning lines that make up the picture, as you do on a big-screen set.

Don't plan to scrap your big-screen set, though. The personal portables aren't meant for family viewing. More than two viewers in front of a tiny TV—especially the four- and five-inch-screen models—makes a crowd.

They're ruggedly built. The flyweights will ignore jouncing and rough treatment that would send a conventional TV to the repair shop. And they're equipped to travel: A carrying case or snap-on protective front lid comes with (or is an optional accessory for) every set. All of the small TVs performed flawlessly dur-

ing the PS tests, although we didn't test them long enough to judge their lifetime durability. But a transistorized TV should be more trouble-free than a tube set, since the two major causes of TV-set breakdown—burned-out tubes and circuit components overheated by glowing tubes—have been eliminated.

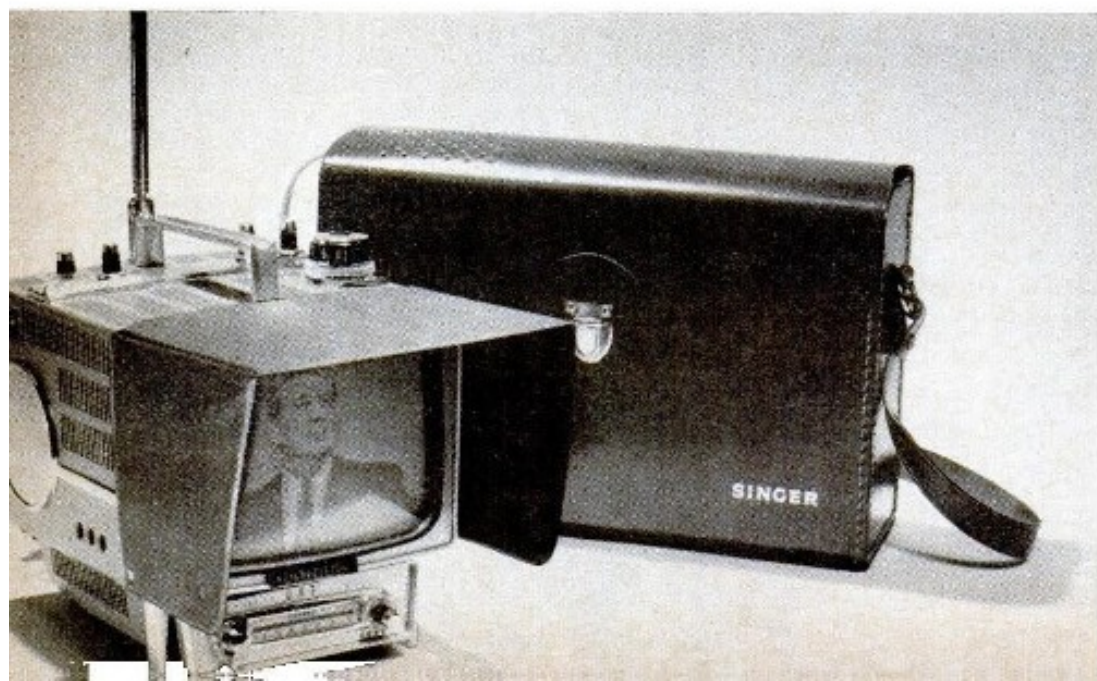
Servicing is no problem. The baby TVs use computer-type plug-in printed circuit boards that most servicemen can fix. For major repairs, the set makers maintain service depots in large cities. The sets are light enough to mail for servicing.

Their performance is amazing—picture quality and sensitivity are excellent. In a side-by-side test in the suburbs the little TVs pulled in 50-mile-plus stations with their built-in monopole telescope antennas alone; a more expensive big-screen set needed a rooftop antenna.

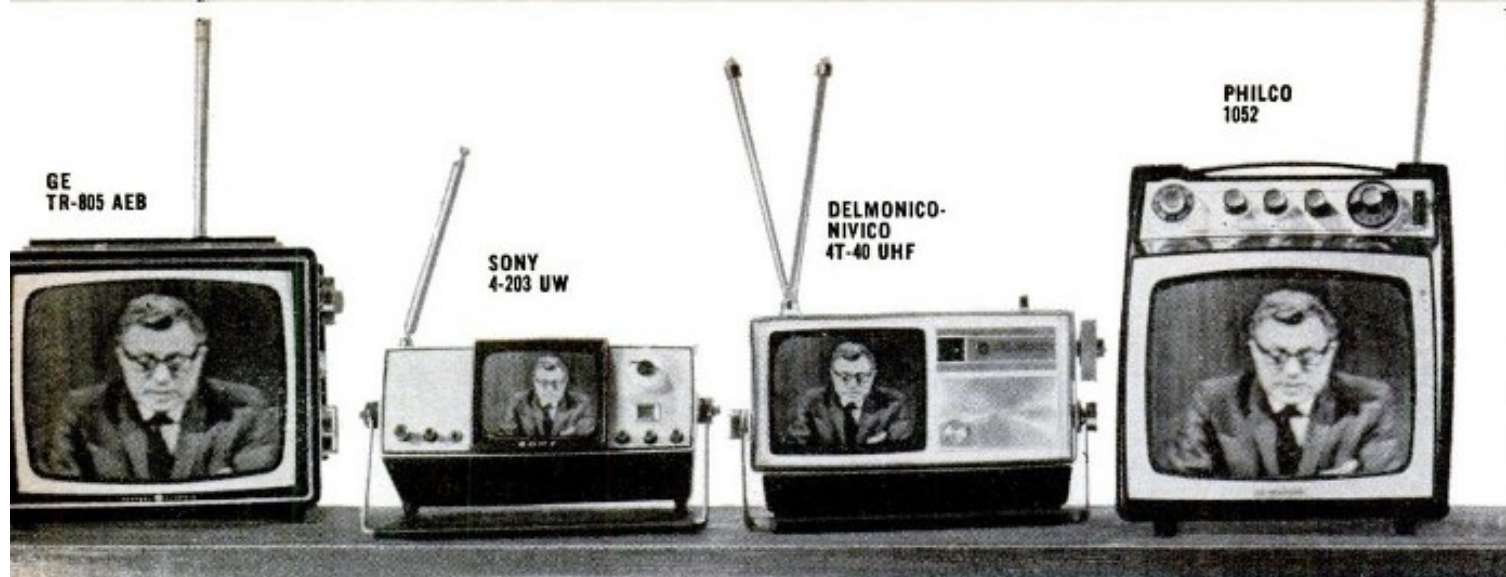
In keeping with the recent federal law, the sets have all-channel tuners, which means they can receive the 70 ultra-high-frequency channels (14-83) as well as the 12 very-high-frequency channels (2-13).

All the little-TV pictures are bright enough for daytime outdoor viewing. At the beach, and on very sunny days, you'll need a sunshade to cut glare on the screen.

How do they sound? Like good-quality transistor radios. To keep power drain low—so they can be battery-powered—these TV sets use relatively low-power



Accessories you'll need to watch the little TVs are shown at left: a sunshade to cut down glare for outdoor viewing, a battery pack to free you from the power lines. Singer's rechargeable battery pack will power its TV about four hours before it needs recharging. Price: \$24.95.



PS ELECTRONICS

Tiny TV Sets

Transistors make them totable, batteries make them portable. Here's your buyer's guide

By Ronald M. Benrey

THE first time you see one of these little TV sets, you may wonder what all the fuss is about. Didn't we get rid of those midget screens back in the early days of television? But the next time you see one—with the picture turned on—it may be a case of love at second sight.

What's happened to TV is the same thing radio went through. First we had only the bulky set in the living room. Then, with the development of transistors and the art of miniaturization, radios shrank. You could carry one anywhere, even put it in your pocket. That's what these tiny TV sets are—personal. They let you watch your favorite show—in your bedroom, car, or boat, at the beach, on a picnic.

Watch out for lampposts when you view Sony's four-inch set powered with flashlight cells. Where's the antenna? It's wired into the neck strap. The whole package weighs six pounds.

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SONY
9-304 UWSINGER
TV60SONY
5-305 UWSHARP
TRP-603

Are "In"

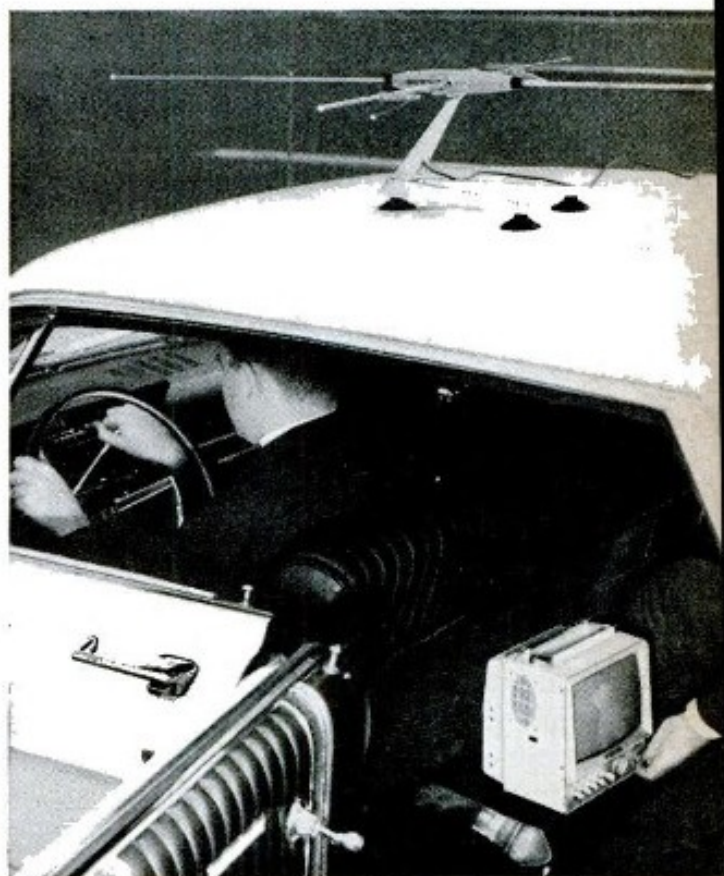
How much do they cost? Prices start around \$150 and range up to \$200—about the same as big-screen portables.

How good are they? To find out, POPULAR SCIENCE tested the eight little TVs shown above. Seven—all except the GE—are from Japan. We were surprised to learn that the Philco set is imported, since Philco manufactured, in the U.S., the world's first transistor TV back in 1959 [PS, Aug '59]. We viewed them in cities and in the suburbs; we took them to the beach and to mountain resort areas; we tried them in cars.

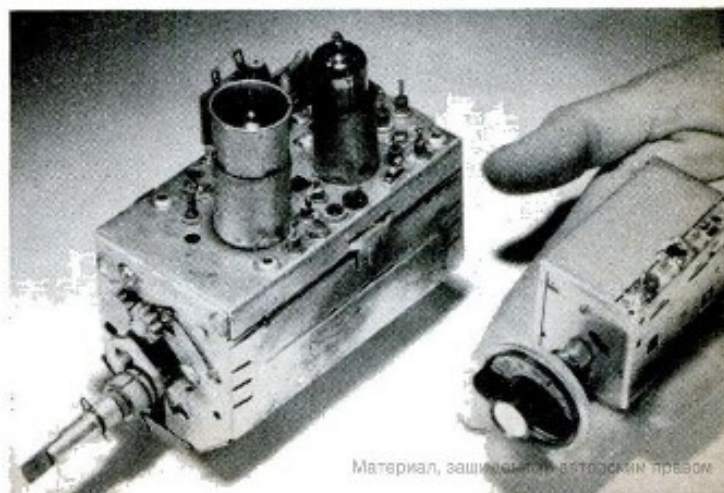
Our conclusions: The personal portables perform so well that they can't help but be popular. Here's why:

The miniature TVs are genuine portables. They are compact—the largest is as big as a bowling-ball bag, the smallest about the size of a desk dictionary. They are light enough to tote around—most weigh under 10 pounds, about $\frac{1}{4}$ as much as a big-screen "portable." They are full-size in performance, though, thanks to sophisticated, space-saving, transistor circuitry.

They can be powered by rechargeable battery packs as well as 117-volt AC house current, so you can view them away from the power lines. Most of the sets will run four hours on one charge;



Back-seat auto TV? Sure—if local laws allow. Sony 9-304 (above) gets power from the cigarette-lighter socket. A rooftop Sony VC2A antenna sucks in the signals. Miniature parts keep the tote-alongs tiny. Shown in photo below, Philco's transistorized tuner stage alongside a conventional vacuum-tube unit.



The '68 CARS—We Pick 13 Winners

OCTOBER 1967 35 CENTS

Popular Science

MONTHLY

How You'll "Drive"
**THE AMAZING
URBMOBILE**



THE GREAT UFO PROBE—

Can You Trust the Upcoming Condon Report?

SELECT YOUR—

- '68 Outboard
- 120 Camera
- New Chain Saw

MAKE YOUR—

- Provincial Desk
- Deep-Hole Drills • Battery Charger
- Lock-Up Gun Cabinet

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A U.S.-backed \$100,000 study at a world-famous lab is working out the design of the commuter's car of tomorrow—and its electric-tracked guideway to the city and back

How You'll "Drive" the Amazing URBMOBILE

By C. P. GILMORE

You gulp the last of your coffee, wipe the egg off your chin, and dash for the door. In the driveway sits a vehicle about the size and shape of a Volkswagen. Beside the door on the driver's side is a handleless hatch. Beneath the car, unseen, are four flanged wheels of smaller diameter than the car's tires. One is attached to the inside rim of each big wheel.

As you slide away from the curb, the sound of the electric drive motor hardly rises above a whisper. A few blocks from home, you steer the car into a special lane, and pull a lever under the dash. The front wheels lock in straight-ahead position. Simultaneously the side-hatch door slides back and an electric third-rail shoe folds out. It makes contact with a power rail, the flanged wheels roll onto rails of a track, and your car accelerates at a controlled rate of 0.3 g. You twirl a dial until you see "5th Street" appear in a small window. Seconds later, as your car enters a main guideway at exactly 60 m.p.h., you open the paper and begin scanning the news.

The system that you're riding: Urb-

mobile. The year: 1985, or perhaps sooner. Right now, a crack team of engineers and transportation experts at the world-famous Cornell Aeronautical Laboratory (CAL) is working on such a system's basic design. If things go well, it could come in the Seventies.

Urbmobile is intended to do something about one of the country's fastest-growing problems: getting people to the city and back. Today, new freeways are jammed as soon as they're built. Downtown areas are choked with cars. Parking is impossible.

Teams of planners across the country are seeking ways out of the worsening crush. Suggestions to date include:

- Minicars that would be driven to downtown areas, then collected and towed away in strings by tractors.

- Pallet systems to whisk cars downtown on special railway flatcars.

- Urbmobile, being studied by CAL under a \$100,000 Department of Housing and Urban Development contract.

Which system or combination might prove practical, no one knows now, but the problem's basic factors are clear:

Cars offer the most convenient door-

Continued

Popular Science

REG. U.S. PAT. OFF.

MONTHLY



Urbmobile combines the advantages of an auto and of rapid transit

to-door transportation, so people want to drive to work. But cars are inefficient people carriers. One 12-foot expressway lane carries less than 3,000 people an hour. And parked cars take up huge amounts of expensive real estate.

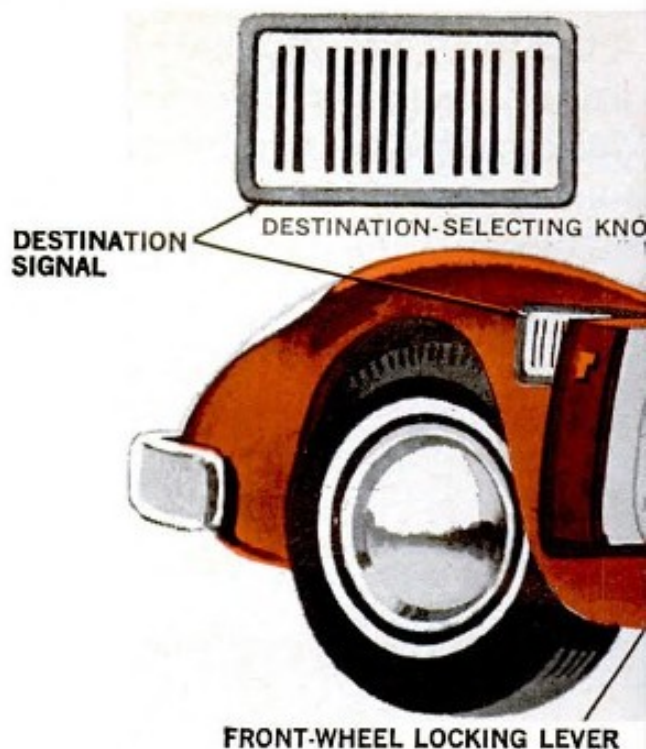
Rapid-transit systems such as subways and trains are far more efficient. A single track carries up to 40,000 people an hour. But rapid transit doesn't haul people door-to-door.

Urbmobile is designed to combine most of both systems' advantages, and few of either's drawbacks. "What we wanted to invent," says Robert A. Wolf, head of the transportation research department at CAL, "was a door-to-door system with high capacity—something like rapid transit combined with the convenience of the automobile."

You feel the car decelerate and look up from your paper. You're gliding into the 5th Street Station. You fold your paper as the Urbmobile comes to a gentle, automatic stop. A gate in a low wall swings open on each side of the guideway. You step out and head for your office a few blocks away. As you leave, your driverless Urbmobile pulls out, and heads back for the main track. Fifteen minutes later it slides into a parking stall 12 miles from the downtown congestion.

The Urbmobile concept may sound futuristic. But its development would require no breakthroughs, not a single discovery. "All the equipment needed," says project engineer Morton I. Weinberg, who heads the CAL Urbmobile task force, "is essentially state-of-the-art. That doesn't mean it's off the shelf, but we know how to build it."

A car could be driven, for example, by a three-phase induction motor locked to the frequency of the electric power supply. All cars would be tied to this system, so all would automatically run at the same speed—60 m.p.h. Such a system would be accurate to within two or three percent. One car might slowly overtake another; they'd nudge gently, though, with bumpers designed to cushion the contact. It wouldn't hurt anything for two to run along touching.

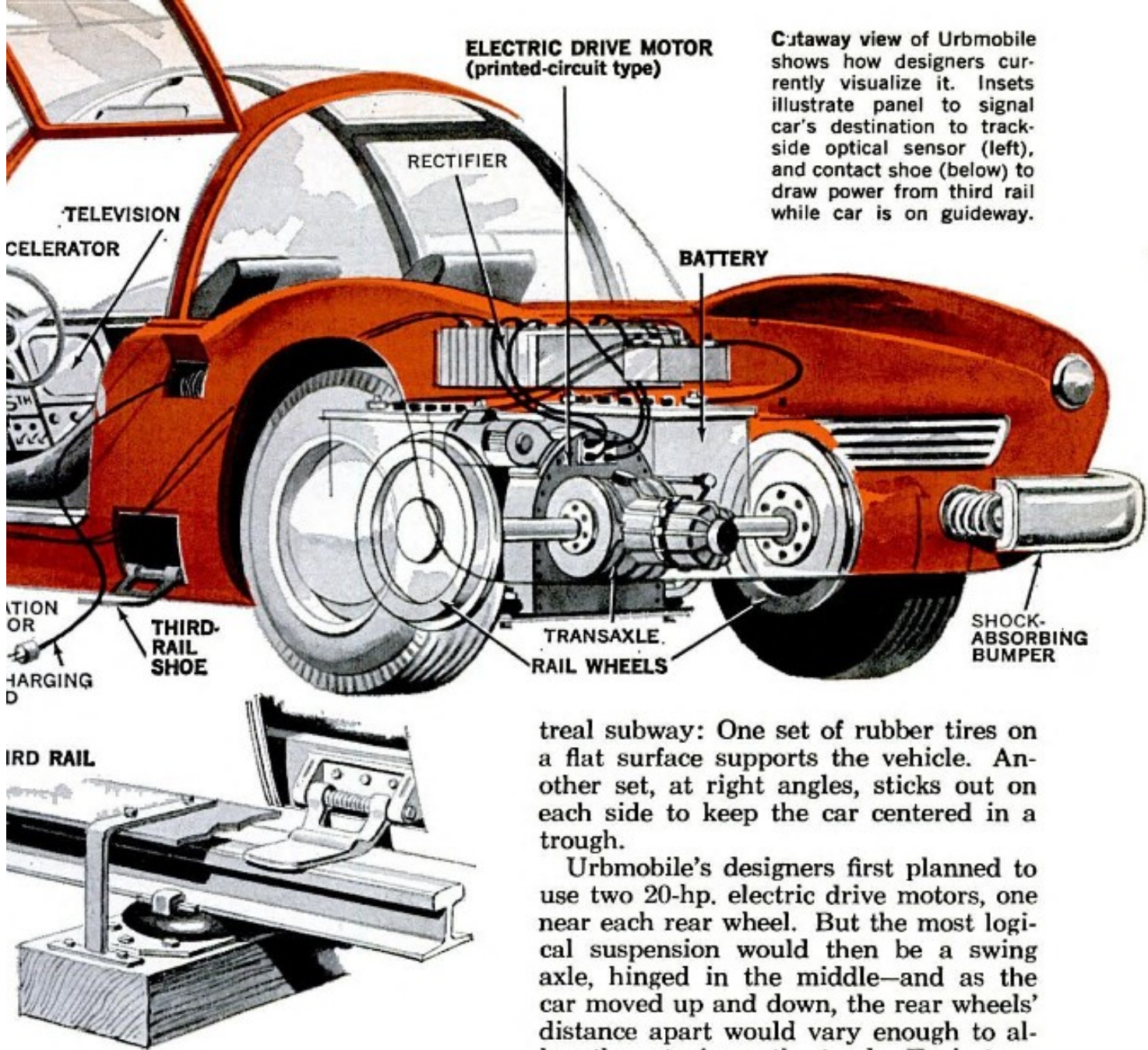


Off the guideway, DC current from the car's battery would be changed to AC by silicon-controlled rectifiers. A frequency-control system would vary the frequency of the power as you pushed or released the accelerator, giving speed control. (The GM electric car demonstrated last year used a similar system.) When your Urbmobile entered the guideway, its contactor would touch a special segment of third rail with a built-in frequency-control system, which would accelerate the car smoothly to 60 m.p.h. before feeding it into the mainstream of traffic.

On the street, Urbmobile's top speed would be 40 m.p.h.; its range, 40-80 miles. That's adequate for commuting, trips to the supermarket, and other uses around town. And there's no reason Urbmobile guideways couldn't eventually run from one city to another.

Either on the guideway or on the street, the Urbmobile would cost about half as much to run as present cars. And it would leave no trail of air pollution behind it.

While differing from present cars in many ways, an Urbmobile will resemble them in others. Urbmobiles will probably be built by today's auto makers, on the same production lines, and will offer



Cutaway view of Urbmobile shows how designers currently visualize it. Insets illustrate panel to signal car's destination to track-side optical sensor (left), and contact shoe (below) to draw power from third rail while car is on guideway.

treel subway: One set of rubber tires on a flat surface supports the vehicle. Another set, at right angles, sticks out on each side to keep the car centered in a trough.

Urbmobile's designers first planned to use two 20-hp. electric drive motors, one near each rear wheel. But the most logical suspension would then be a swing axle, hinged in the middle—and as the car moved up and down, the rear wheels' distance apart would vary enough to allow them to jump the track. Easiest solution was to put them on a common axle and go back to a conventional differential, and probably a single drive motor. The Cornell group thinks standard front-wheel suspension, which tends to keep the front wheels' contact points almost constant, can probably be used just about as is.

Anticipating trouble. To assure a safe system, Weinberg and his group spend a lot of time thinking of all the things that could possibly go wrong, and what would happen if they did.

What if a car's third-rail shoe breaks or its motor burns out, and it loses power? "There may be other cars coming up behind you," he says, "and their drivers may be napping or reading the paper.

Continued

much of the variety that today's cars do. "They'll all have to fit the track and the third rail," says Weinberg, "but they could have different colors, body styles, and accessories."

CAL's planners emphasize that their study is in an early stage. Features that look good now may change.

Cars running on steel wheels offer the best promise, they've tentatively decided. A steel wheel doesn't get flats. Flanged wheels on steel rails don't skid. And there's no guidance problem that hasn't been solved years ago by railroads. "When an automobile is on the guideway," Weinberg says, "it's just a little conventional trolley car."

But there are other possibilities. Urbmobile might be built, say, like the Mon-

The race is heating up for TV You Can Hang on

New ways of controlling light electronically promise to replace picture tubes with flat screens

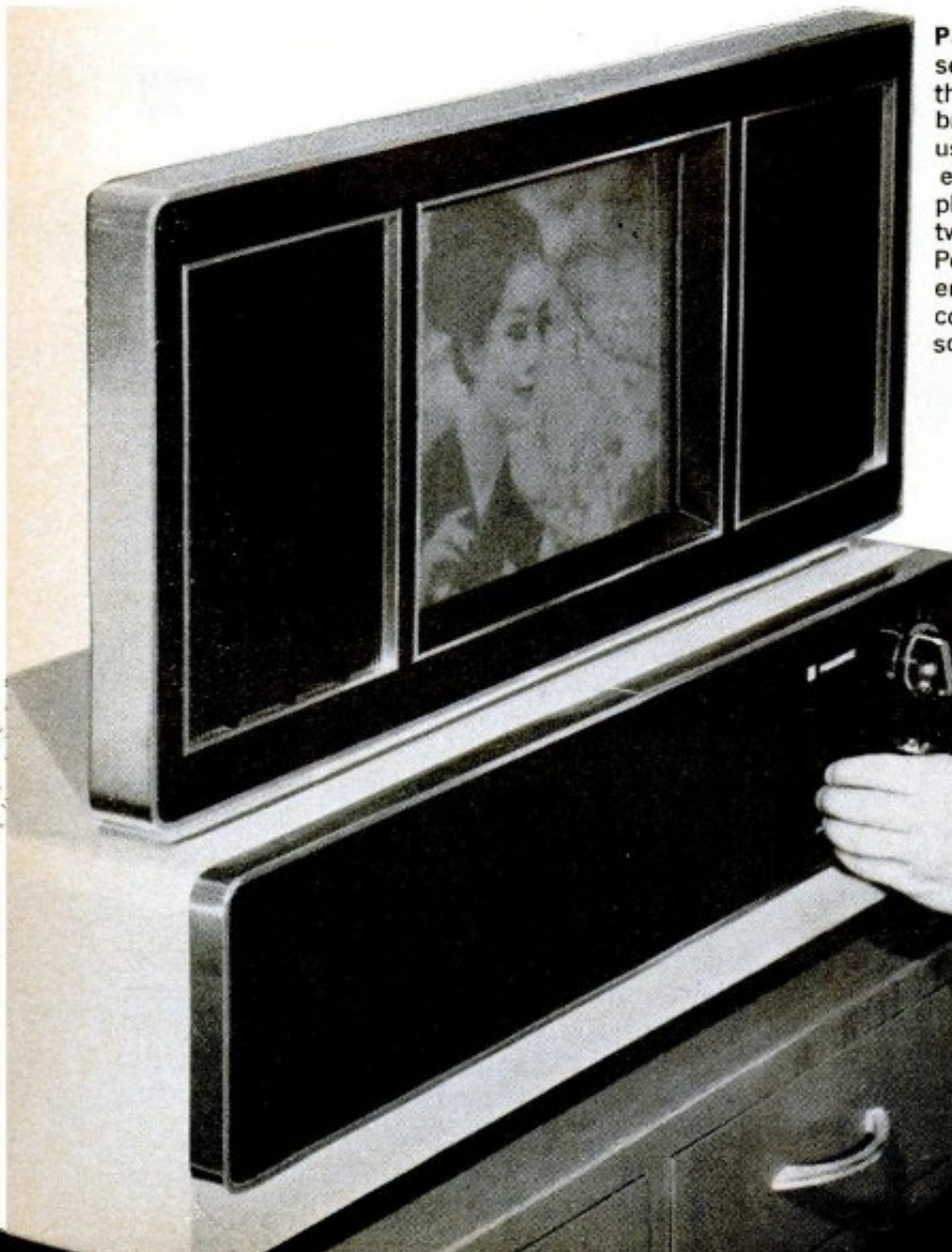
By R. M. WALSH

"Tubeless" transistorized TV is great, but wouldn't you like a *really* tubeless set—a flat-screen or "mural" TV, thin enough to fade into the woodwork?

The race is on to eliminate the biggest,

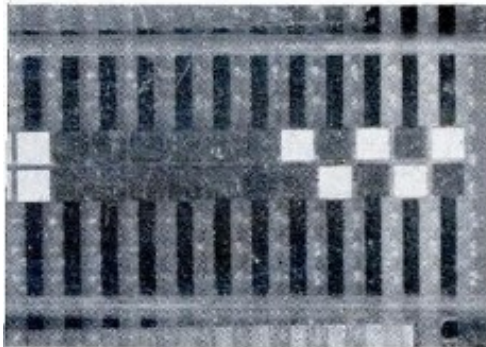
most power-hungry tube of them all. The advantage of slim size is obvious; the fringe benefit of reduced electrical appetite would make "portability" really meaningful to the totter.

Matsushita, whose products are well known in this country under the Panasonic label, is eager to be the first with mural television. They certainly have shown the most progress publicly. Earlier this year they displayed a working model of a flat-screen set.



Panasonic flat-screen set really works, although resolution and brightness are poor. Set uses sandwich in which electroluminescent phosphor is the filler between two electrodes. Perhaps available in several years, whole set could be as thin as the screen alone.

a Wall



Tiny RCA flat-screen set has superb resolution and contrast (right) but can handle only still pictures.



For real television, system would require third of a million "on-off" circuit elements seen at left.

Electro-optics is the game. To develop a mural screen, scientists and engineers are dipping into a whole new bag of tricks: the growing field of electro-optics, or the science of using and controlling light electronically. Matsushita is using an electro-optical effect already familiar to most all of us—electroluminescence, or EL. The best known EL device is the compact night light that plugs into a wall outlet and glows a dim but reassuring green. Green is the color usually available by EL, but scientists have developed variations in the EL phosphors that produce other colors, including white.

In an EL device, an electroluminescent phosphor is the "filling" in a sandwich. The phosphor layer lies between two electrodes. Although the normal 60-cycle, 120-volt power available directly from a wall outlet can be used, the light output is improved if both voltage and frequency are increased.

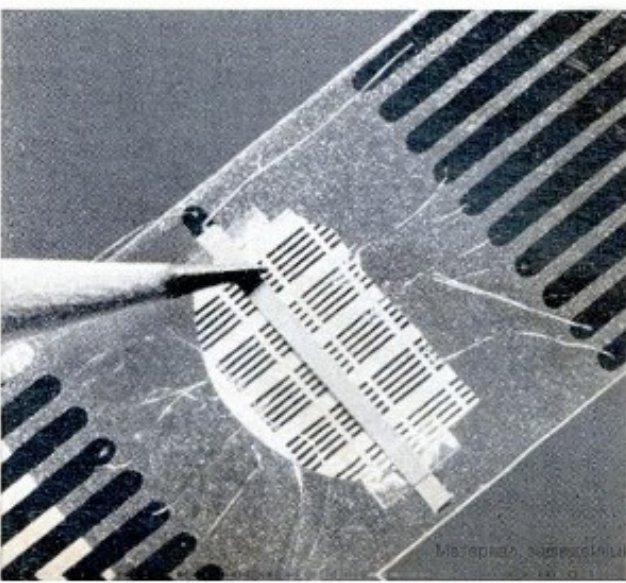
Matsushita demonstrated a mural TV prototype with a 13-inch screen, made up of an array or "matrix" of tiny EL cells. The array had 230 lines, each containing 230 cells. This gives a total of 52,900 individual cells that blink on and off to form a picture—still far from the number of cells needed to give the resolution available from a conventional picture tube.

How this system works. Matsushita uses what has come to be known as x,y addressing. Each cell in a vertical column is con-

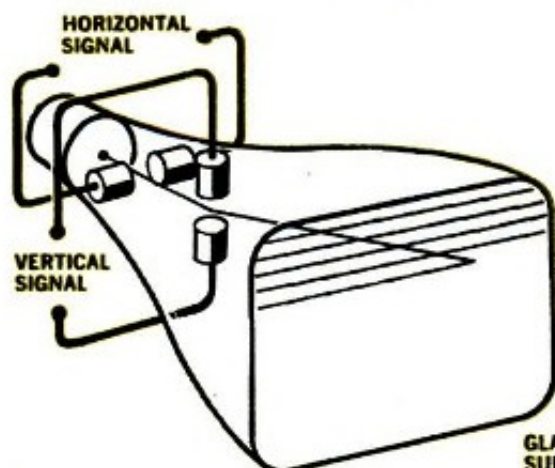
nected with a transparent electrode on the front of the screen, giving a total of 230 electrode strips. Similarly, each horizontal row is connected with an electrode strip across the back, giving another 230 electrodes. Just as an intersection in New York can be located by designating Fifth Avenue and 42nd Street, an individual element in the EL matrix can be addressed by applying a voltage across, say, vertical column electrode 73 and horizontal row electrode 231. In the Matsushita display, an entire row is addressed at a time, with the appropriate brightness voltages applied to the individual column electrodes simultaneously, but with only

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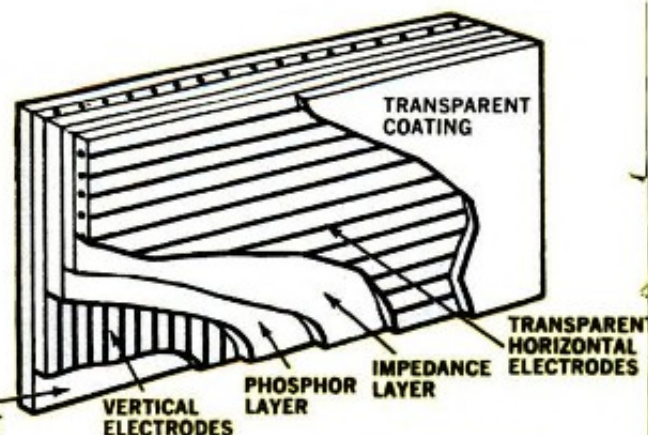
Tiny color cells are visible in this experimental color filter devised by Sandia Laboratories. Filter can "strain" any desired color out of white light electronically, change color at will.



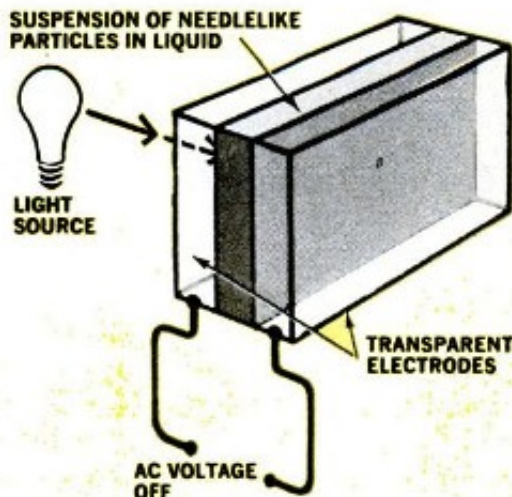
Which system will replace the picture tube?



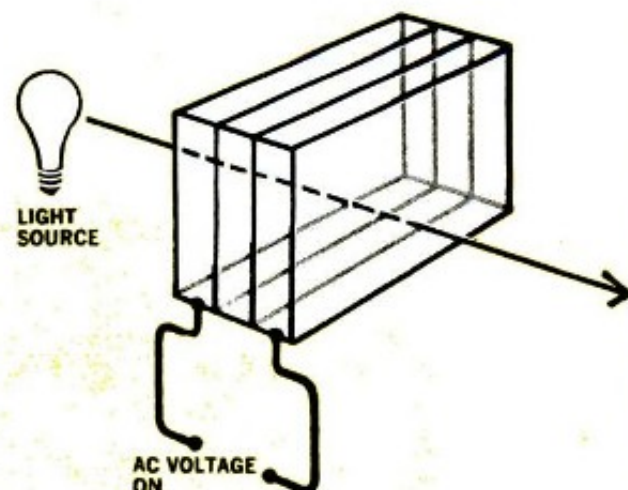
In the conventional cathode-ray picture tube, or CRT, a beam of electrons sweeps out the picture on a fluorescent screen. Electromagnetic coils control beam's direction, so it "addresses" correct spot on screen. Lines on screen are scanned so fast that your eye perceives complete picture all the time.



Panasonic flat screen uses electroluminescence. Voltage applied across any vertical and horizontal electrode pair will light EL phosphor at intersection. Actually, picture is addressed a row at a time and not spot by spot, as in CRT. Impedance layer is sandwich gives clean switching of picture elements.



The Varad system, by Marks Polarized Corp., uses cells with opaque suspension of tiny, needle-like particles. If DC voltage is applied, needles align,



permitting light to pass. Marks hasn't built a TV screen, but claims to have achieved the high switching speeds needed for a working flat-screen model.

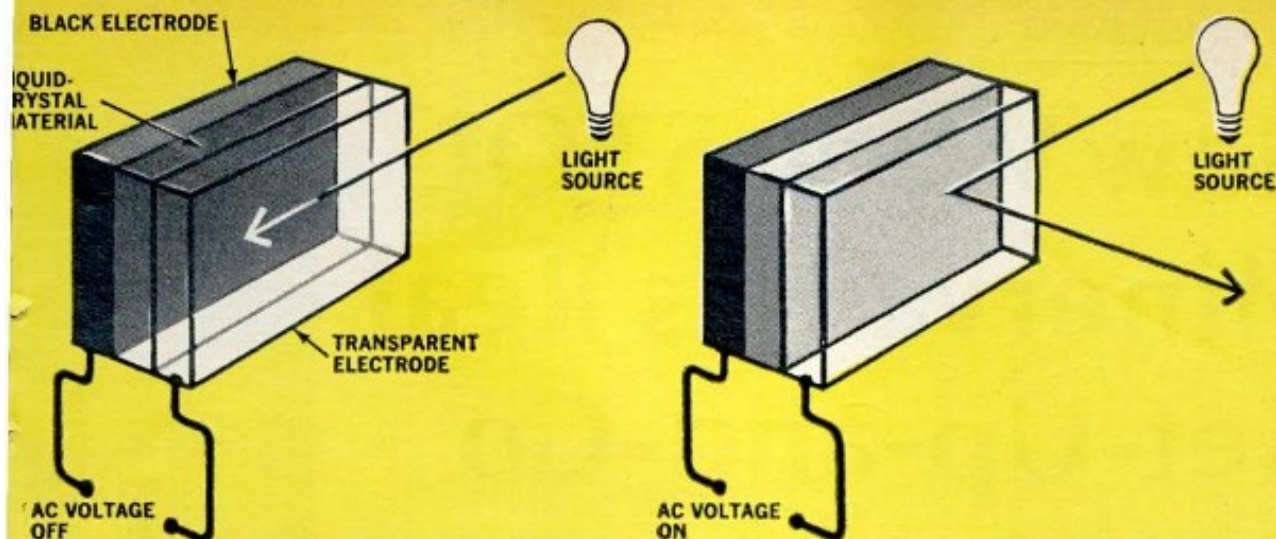
the one desired row electrode connected. Unfortunately, without other measures, a significant voltage will appear across the elements that should be "off" in both the addressed row *and* in the other 299 rows; the cause is capacitive interaction. To prevent this, a blanking voltage is pulsed to the "off" rows, which to a large extent cancels out the capacitive effects.

Not bright enough—yet. The prototype Matsushita flat-screen set doesn't come up to the conventional picture tube's resolution and brightness, so it probably won't become a commercial reality in the very near future. The set did, however, become the first mural TV far enough along to

justify a public showing and give us an inkling of what's to come.

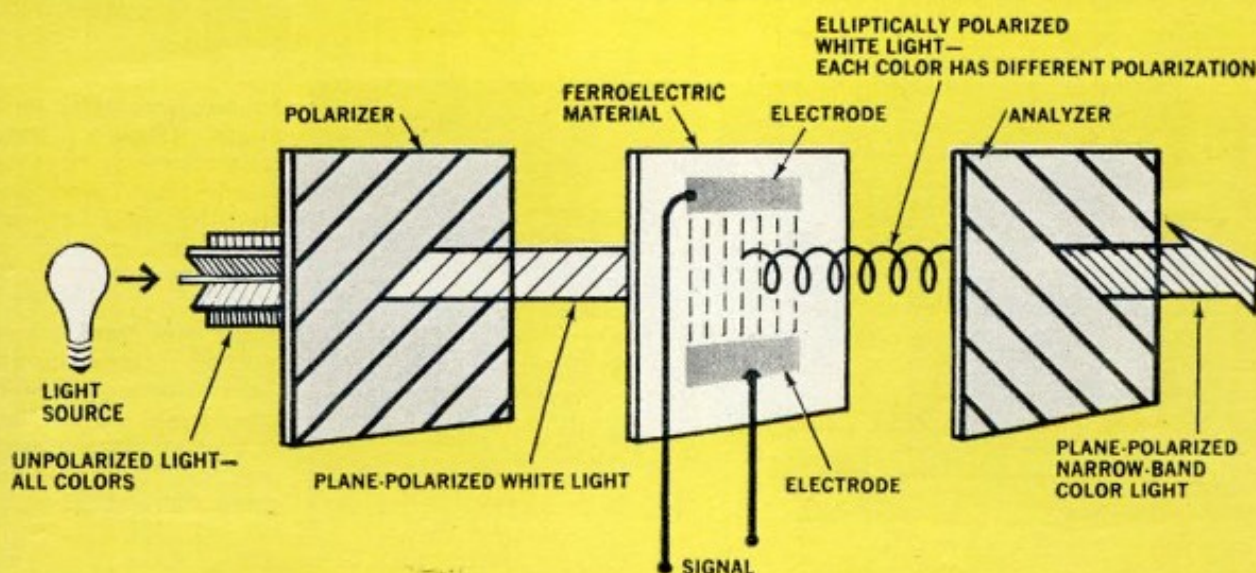
Close on its heels, another entry from across the Pacific was unveiled, this time by Mitsubishi Electric. The Mitsubishi screen is only about three by four inches, with a bare 80 lines. Obviously, its resolution is respectable only for a laboratory device; it also suffers from inadequate brightness. Like the Matsushita display, it uses an EL array, and a similar crossed-electrode grid, or x, y addressing scheme. The details of its workings are still safe in Tokyo.

We're in the race. Don't let all of this Japanese activity make you think that



RCA's liquid-crystal display also uses crossed-electrode addressing grid. Drawing shows only one picture element. Before AC voltage is applied, light

goes through liquid crystals and is absorbed by black electrode; after voltage is applied, liquid-crystal layer becomes white, reflects light.



How Sandia's color filter works: Polarizer passes only plane-polarized white light. A ferroelectric plate, controlled by electrical pulses, gives the de-

sired color component of the white light just that specific polarization that will enable it to pass through the analyzer—a second polarizer.

there is an American "television gap." RCA has owned up to working on EL displays in their Princeton, N.J., laboratories, although they haven't shown an example of their efforts to the public. But they have recently been willing to talk about another one of their approaches to mural TV: "dynamic scattering" from liquid crystals.

Liquid crystals are materials that have some properties of both liquids and solids. The liquid crystals that RCA is using have a particularly interesting property—normally transparent, they become turbulent and cloudily opaque when an AC voltage is applied across them.

The liquid-crystal system. As in the case of EL displays, liquid crystals are used in a sandwich arrangement between two electrodes. Here again the electrodes for an array of cells are connected in a crossed grid of vertical columns and horizontal rows. A dark background is visible through the clear cells. When a voltage is put across any cell, it clouds up and reflects room light or sunlight. The screen does not supply any light at all; it simply controls the reflection of outside light to form a picture.

Thus the term "dynamic scattering"—the light is scattered; "dynamic" refers to

[Continued on page 192]

SEPTEMBER 1969 50 CENTS

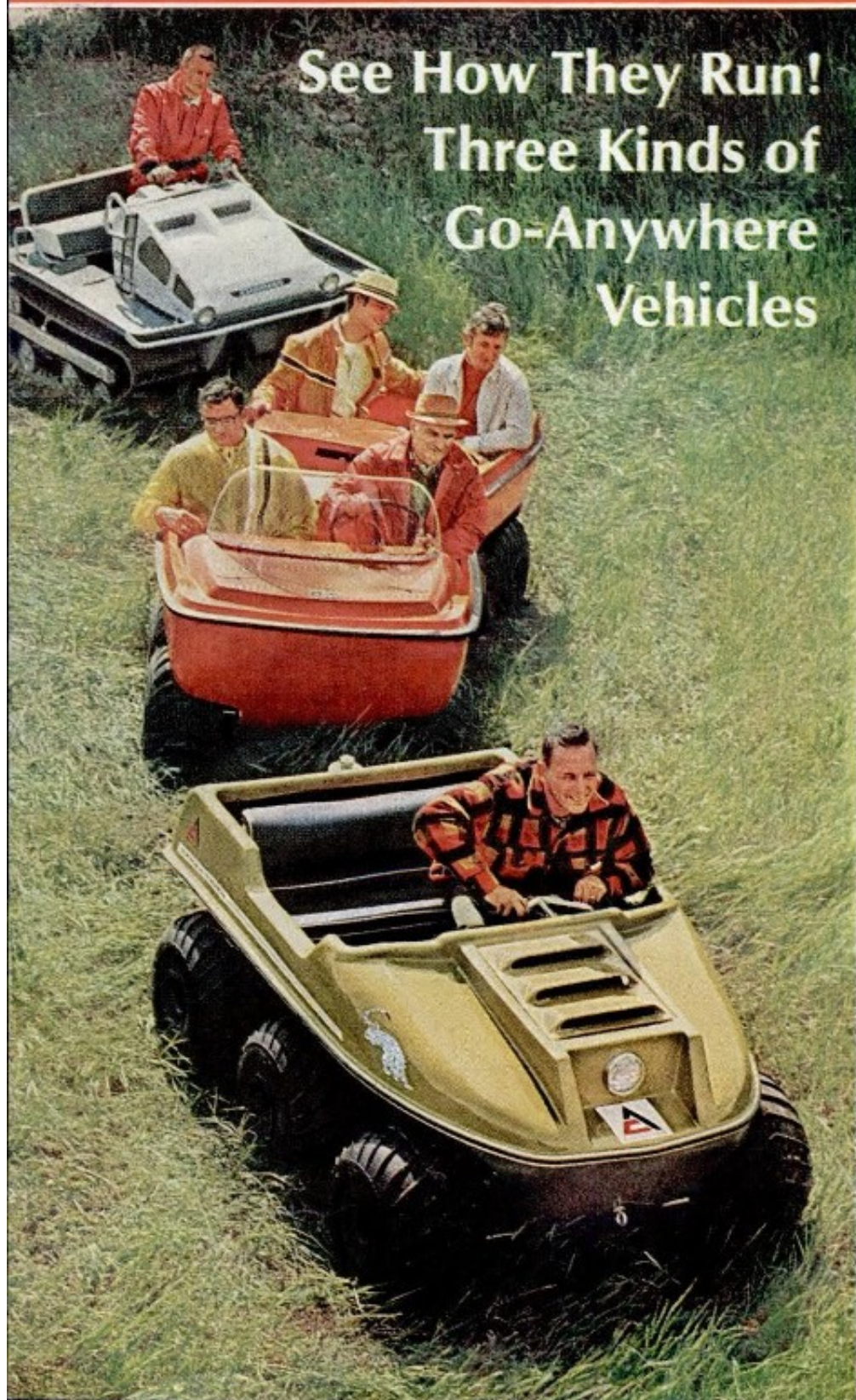
Popular Science

THE *What's New* MAGAZINE

Starting this Issue
**Scott
Carpenter**

writes about
**The Frontiers
Under the Seas**

**See How They Run!
Three Kinds of
Go-Anywhere
Vehicles**

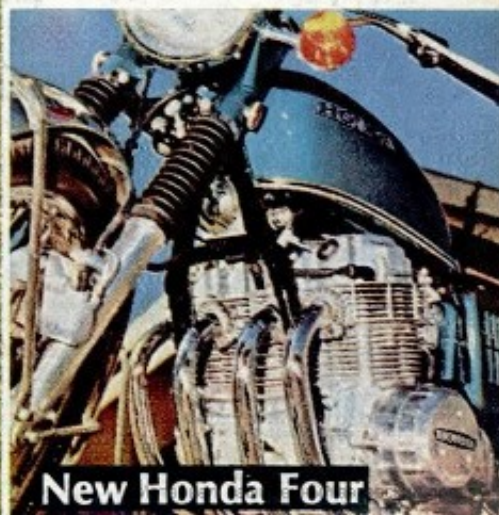


Double-Deck Gazebo



**Improve Your
Home & Yard**

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WHEELED, TRACKED, OR ARTICULATED

What Kind of ATV Is Best for You?



Go-anywhere all-terrain vehicles (ATVs) are busting out all over the landscape. Here's a look at the main types now available and what they do best

By E. F. LINDSLEY

PS Outdoor Power Equipment Editor

PHOTOS BY ORLANDO GUERRA

Pack the agility of a mountain goat and the bog-happy abilities of a muskrat into a single powerful, rough, tough machine and you'll come up with an ATV. That's short for All-Terrain Vehicle, the newest fun contrivance, and one that promises to make go-anywhere outings practical year-round. ATVs have been available for awhile, but it's only recently that their builders have really started to vary the proportions of goat, cat, and

muskrat for a more versatile breed.

Because these innovations in design and capabilities are important, PS decided to check out three new and distinctly varied ATVs so that you might judge which type is right for your needs — tracked, wheeled, or articulated.

AMF's eight-wheel-drive Sur-Trek with a uniquely jointed center is the articulated vehicle we selected. The others are Allis-Chalmers' six-wheel-drive Terra Tiger, fairly typical of the single-unit, high-flotation-tire type, and Cushman's hydrostatic-drive Trackster.

A real kick to drive. This goes for each of

Continued

Double-jointed vehicle gets the bends to carry you over anything



Double-jointed AMF Sur-Trek wallows over little valleys bending both nose and rear upward in a fine demonstration of the value of its articulated design.



Articulation also helps AMF climb hills. After front of vehicle crosses crest of hill, front wheels hold it there, while four rear wheels dig in and add bite.



Cruising through a deep bog is no problem for the AMF, and the steering is ideal — Sur-Trek handles like a boat even when you're traveling on dry land.



Editor Lindsley piloting the articulated AMF finds it requires that you anticipate turns and recoveries. It's like steering a boat with a rudder control.

the machines. Steering, throttles, brakes, and handling techniques differ, but practice only a minute or two with any one and you find yourself blasting off across the landscape with the aplomb of a veteran. Confidence builds as you become accustomed to the low, low centers of gravity, jolt-absorbing abilities built into the wheels and suspensions, and the snappy two-cycle engines that fairly leap into action.

To compare the advantages and drawbacks of each type, we broke down their

test performance into these categories:

- Over-the-ground ride and speed
- Steering and handling
- Climbing ability
- Water and bog capability
- Load capacity and utility
- Structure and drive train

For sheer scat and easy ride, the six-wheeler does a top-notch job, especially when you consider that the 10-hp. JLO L252 engine is a bit smaller than the engines in the other ATVs we tested.

The Terra Tiger steers accurately and



Two-part AMF vehicle has a huge load-carrying capacity, holding as many as four with gear.



Crank at right end of front cable turns shaft that transmits steering via cable to wrench rear car around. Then front car follows—like tail wagging dog.



Grooved pulley transmits steering commands from control wheel by turning a shaft, which engages a telescoping wagon tongue running back to rear car.

well. Our only complaint was the lack of reverse. Sometimes natural temptation leads an ATV driver into spots he'd rather back out of on second thought.

AMF's Sur-Trek is a truly novel machine resembling two roller-coaster cars linked together. Power feeds to all wheels on both cars from the 20-hp. engine in the rear car. The two cars will seat four or five persons, or the rear could be used to haul a hod full of camping gear.

The speed is good, but the ride is more sedate and the turns less dramatic than

on smaller ATVs. The articulated center joint allows the front and rear cars to wallow individually over hummocks and the Sur-Trek slinks through ditches and humps over ridges like a snake. Power from the JLO 295 is plentiful and you have a choice of conventional foot throttle or a hand throttle — the latter for control in tight spots.

Brakes are pedal-operated but the pedal tends to ride high and it's a bit hard to yank your foot high off the throttle and onto the brake.

Continued

Tracks and bogies have great spring—you tense for jolts that never come



Tracked Cushman ATV does more pitching and bumping over rough terrain, but suspension absorbs most of jolts. Springing in tracks and bogies does the job of cushioning.



Cushman Trackster has electric start for its 25-hp. OMC two-cycle engine. Tee handle (center) gives you wrist steering and advantage of speed control at the same time.

Access to engine of Cushman is extremely easy—you merely release panel latches and lift out front hood and dash panel. There's an impressive hydraulic oil-cooler radiator.



Trackster cruises through a bog with little trouble. Its tracks seem to perform as well as wheels in control and going power through shallow water.

Steering an articulated vehicle proved tougher than steering the others. Turning functions on the principle of the tail wagging the dog. A car-type steering wheel with a drum and cable, like an outboard motor rig, operate a rather large grooved pulley or sector wheel mounted on the bulkhead behind the driver's seat. The sector wheel turns a shaft extending through into the space between the two cars and swings an arm which, in turn, engages a telescoping wagon tongue reaching back to the rear car.

Thus, a turn on the steering wheel travels via cable to the sector wheel and lever arm to wrench the rear car around. In due course, the front car follows. With the Sur-Trek, you learn to anticipate turns and start them a bit early. You also start your recovery early. The general impression is that of steering a boat with rudder control.

Maneuvering is a joy. With the Cushman (Outboard Marine Corp.) Trackster, you'll find yourself making on-the-spot turns that actually trace a true circle on the ground. This, of course, is a bonus of the Sunstrand hydrostatic drive that permits locking or reversing either tread while the opposite one goes forward.

A single T-handle mounted vertically at front and center on

Tracked-vehicle suspension consists of individually suspended bogie wheels held by rubber mounts and steel springs. Track is of one-piece rubber.



A little practice and you blast off like a veteran



Bird's-eye view of Allis-Chalmers Terra Tiger shows roller chains (foreground) that drive sprockets on each of six wheel axles. Engine is a 10-hp, two-cycle JLO.



Terra Tiger splashes through a bog with only a few dubious moments. Speed is about that of a paddling bird dog. Manufacturer does not recommend a nose-down plunge into the water, but advises that you enter at a reasonable angle.



T-bar steering handle maneuvers Terra Tiger. Turning handle downward disengages steering clutch on side toward the turn. Wheels on other side bring you around.



Quickness of Terra Tiger wasn't diminished despite loss of its right middle wheel, which came off when a hub weld broke. The remarkable little machine didn't even lose any of its hill-climbing capabilities while minus one of the wheels.

the panel gives steering with a twist of the wrist — moved fore or aft the same handle increases or decreases speed.

The hydro transmission is as smooth as silk but it took me two stall-outs on a steep slope to learn one trick: As the engine starts to lug down, you must come back on the throttle. This has the result, hydraulically, of gearing down.

The tracked vehicle seemed to have a bit more pitch and bump over rough ground but the springing on tracks and

bogies is remarkable. You find yourself tensing for jolts that never come. Loose gravel can be alarming. Stones tend to get into the track channels and the crushing action splits them and pops them out with some pretty snappy noises. It doesn't appear to hurt anything.

The ATVs all excel in hill climbing. But again, each type has its own unique advantages, although all are designed to climb a 45-degree grade.

For one or two persons in reasonable

How They Compare

	Dry Weight (lb.)	Overall Length (in.)	Overall Width (in.)	Ground Clearance (in.)	Number of Wheels	Braking	Engine Type	Engine Make
Amphi-Cat	396	81	52	8	6	Drum	2-stroke	Sachs
Attex	450	82½	53	8	6	Disk	2-stroke	JLO
Coot	1,020	91	64	11	4	Disk	4-stroke	Tecumseh
Moto Brousse	475	87	36	11	4	Drum	2-stroke	Sachs
Muscateer	500	84½	52½	5	6	Disk	4-stroke	Kohler
Pug	1,000	138	51	15	4	Drum	4-stroke	Tecumseh
Scrambler	450	95	54	6	6	—	4-stroke	B & S
Sierra Trail Boss	665	89	57	6¾	6	—	2-stroke	Kohler
Stalker	490	92½	63½	8	6	—	4-stroke	Tecumseh
Starcraft	460	72	50	—	6	Disk	2-stroke	JLO
Sur-Trek	600	126	50	7½	8	Disk	2-stroke	JLO
Terra-Tiger	400	86	54	5.37	6	Disk	2-stroke	JLO
Trackster	985	92	61	10	tracks	Hydrostatic	2-stroke	OMC
Wolverine	1,975	113	66	11.7	8	Drum	4-stroke	FORD

hill country, the six-wheeled vehicle does just fine. The Terra Tiger is close-coupled and takes a 45-degree hill nicely—even climbed one on five wheels after a hub weld broke on a center wheel.

The Trackster offers an escape route not available to wheeled vehicles. Force it up too steep a grade and it slithers off sideways and comes back down nose first.

The hydrostatic drive, low center of gravity, and side-sliding action of the flat tracks make this possible.

The big, sedate, double-jointed AMF Sur-Trek has amazing hill-climbing abilities. Its extra two wheels give added bite just when it's needed to help the huge machine slither up steep grades.

In some areas, ATV owners couldn't



Dashing through water is a cinch for Attex ST-300, a rugged six-wheeler that can do 35 m.p.h. on land.



Pug, in wild country, easily maneuvers around a big boulder with the aid of its double-jointed design.

Scrambler ATV scampers through snow like a snowmobile with the help of its six big flotation tires.



Stalker is a brand new entry in ATV field. It uses twin control sticks for steering and acceleration.



Power Output (hp.)	Max. Land Speed (m.p.h.)	Max. Water Speed (m.p.h.)	Range on Land	Price (f.o.b. factory)
16	37	1-2	10 hrs.	\$1,295
20.5	35	4	5 hrs.	\$1,495
12	20	5	2½ hrs.	\$1,695
14	30	—	140 mi.	\$1,595
8	14	1	6-8 hrs.	\$1,595
12	22	—	7 hrs.	\$1,795
7	20	2	—	\$1,395
20	35	5	—	\$1,495
12	30	4	5 hrs.	—
14	30	3	—	—
20	30	2	6-9 hrs.	—
10.1	25	4	5-6 hrs.	\$1,425
25	16	—	5-6 hrs.	—
55	35	3	200 mi.	\$4,884 •

care less about bogs, muck, and swamp water. They're happy traveling over sand, rock, ice, or snow. But many prospective owners envision crossing geological swarf, sludge, and marshland to duck blinds, island camping spots, hidden fishing holes, and bird-watching nooks.

Face it; an ATV is not a speedboat or a

[Continued on page 204]



Compact Starcraft ATV has a fiberglass body that's built to take rugged punishment in woods or swamps.



New Sierra Trail Boss has a planetary-gear steering transmission that is controlled by two levers.



New B9 Amphicat, 10 percent faster than its earlier brothers, has a new torque-sensitive transmission.



Huge Wolverine is a real workhorse. Its 55-hp. Ford V-4 is largest engine in any of the ATVs shown here.

Four-wheeler Moto Brousse has smaller steering wheels in rear and larger drive wheels in front.



Muscateer is highly maneuverable, turns in its own length by stopping wheels on one side; others push.



EVR —Canned Movies from Your TV Set

Electronic Video Recording is the latest technological breakthrough for education and home entertainment

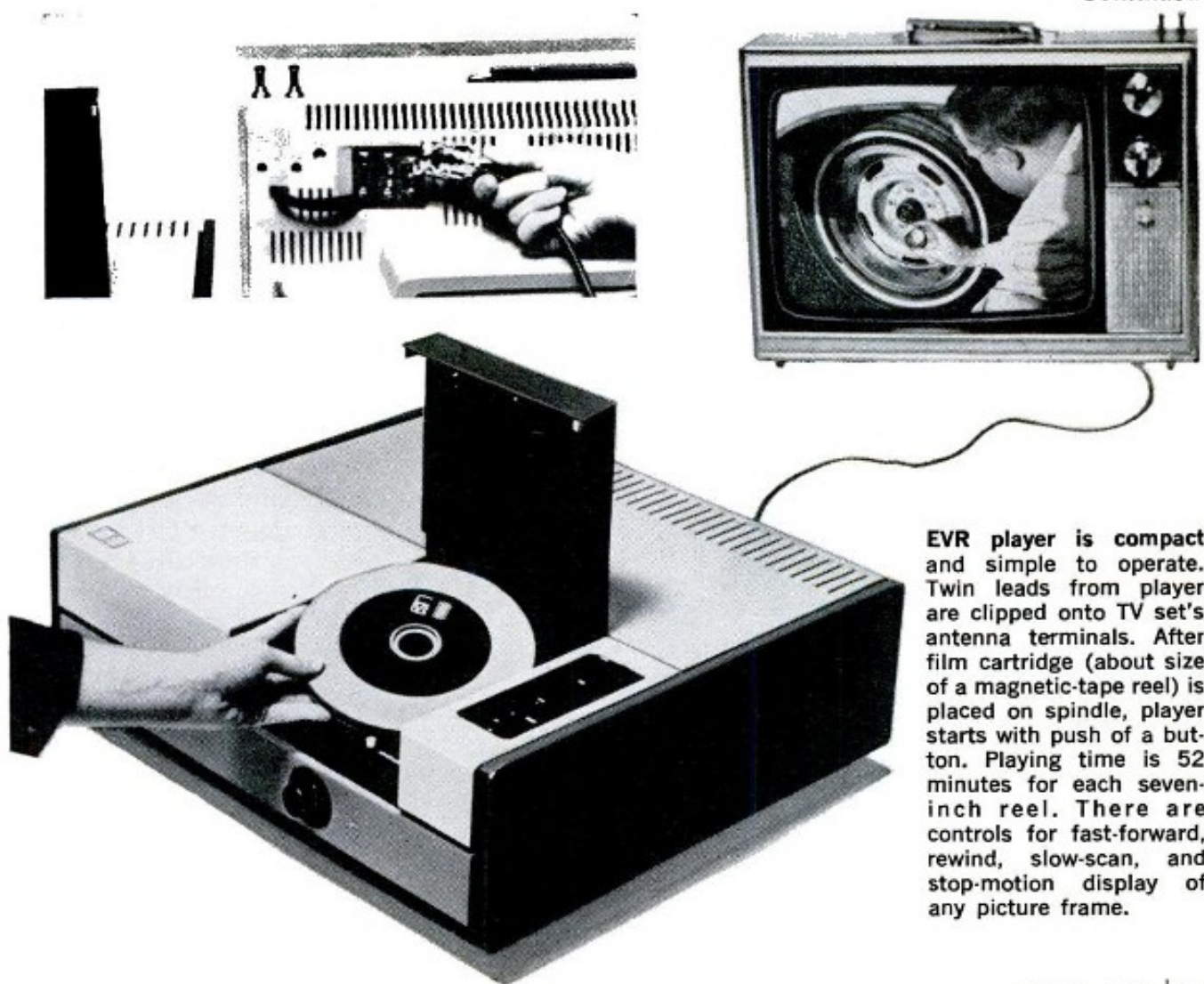
By SAM SHATAVSKY / *Electronics Editor*

A complete audio-visual entertainment and educational center in your home—that's what is coming with the introduction of CBS's new electronic video-recording system (EVR). Just as a long-playing record stores sound conveniently and inexpensively for later replay on a record player, EVR stores pictures

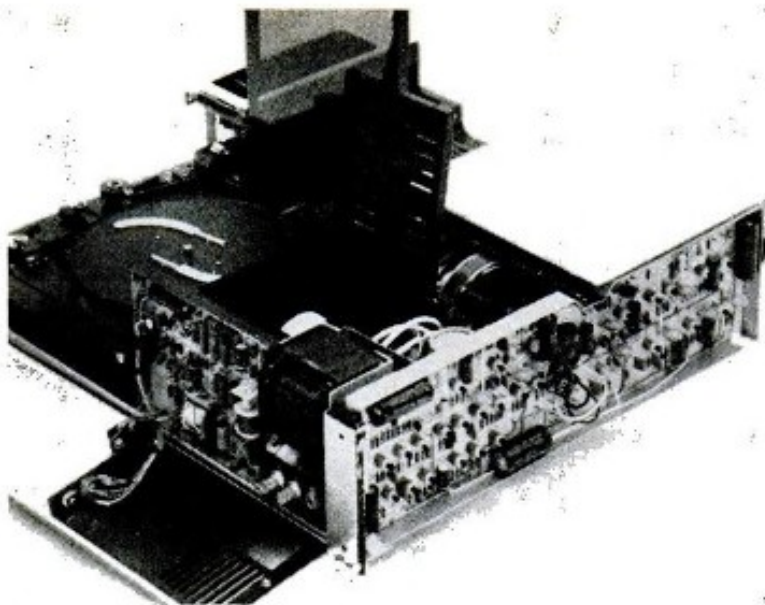
and sound on a reel of film for playback through a standard television set.

Nothing like videotape recording. EVR uses electron-beam image recording on film to generate extremely small picture frames identical with those on movie film. The film is for playback only; you will not be able to make your own recordings, but will buy ready-made program reels produced by CBS and its licensees. Any motion picture, video-

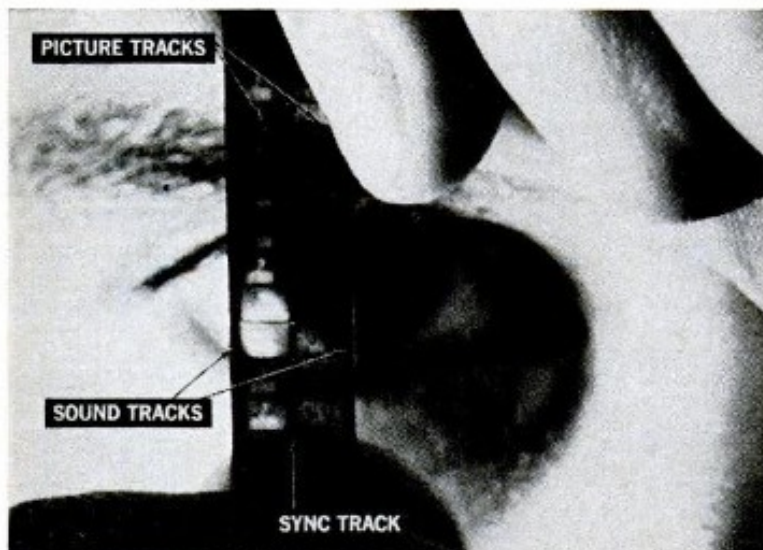
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EVR player is compact and simple to operate. Twin leads from player are clipped onto TV set's antenna terminals. After film cartridge (about size of a magnetic-tape reel) is placed on spindle, player starts with push of a button. Playing time is 52 minutes for each seven-inch reel. There are controls for fast-forward, rewind, slow-scan, and stop-motion display of any picture frame.



Player chassis houses electro-optical transducer system: the flying-spot scanner, photomultiplier, and electronic circuits, together with automatic-threading film-transport mechanism.



Thin film is dual-tracked and carries magnetic sound tracks on outer edges. Synchronized-light windows allow speed control without sprocket holes. Picture frame is $\frac{1}{8}$ by $\frac{1}{16}$ inch.



In classrooms, EVR is expected to play leading role, providing selected programming at teachers' discretion and convenience. Students will also operate easy-to-use players in learning labs.

tape, or live television program can be commercially recorded for EVR playback.

The whole family benefits. An EVR cartridge is about the size of an ordinary seven-inch magnetic-tape reel. By simply inserting one into the playback machine, Dad can sit at his TV set for an evening of golf lessons. Junior can bone up for a science exam with cartridges from the public library. Mother can take homemaking, bridge, or language courses. For entertainment, you'll have a choice of the latest movies, plays, and concerts. This will all come through your TV screen via the EVR player.

Because this new video recording system has a horizontal resolving power of up to 600 TV lines per picture frame, without interlace, picture quality is excellent.

EVR is also superior to magnetic videotape because of its high-speed low-cost duplication and the low cost of the film. It is predicted that cartridges will sell at the same price level as records with about the same playing time. Low film speed (six inches per second) gives fewer transport-mechanism problems—another advantage over the high-speed videotape machines.

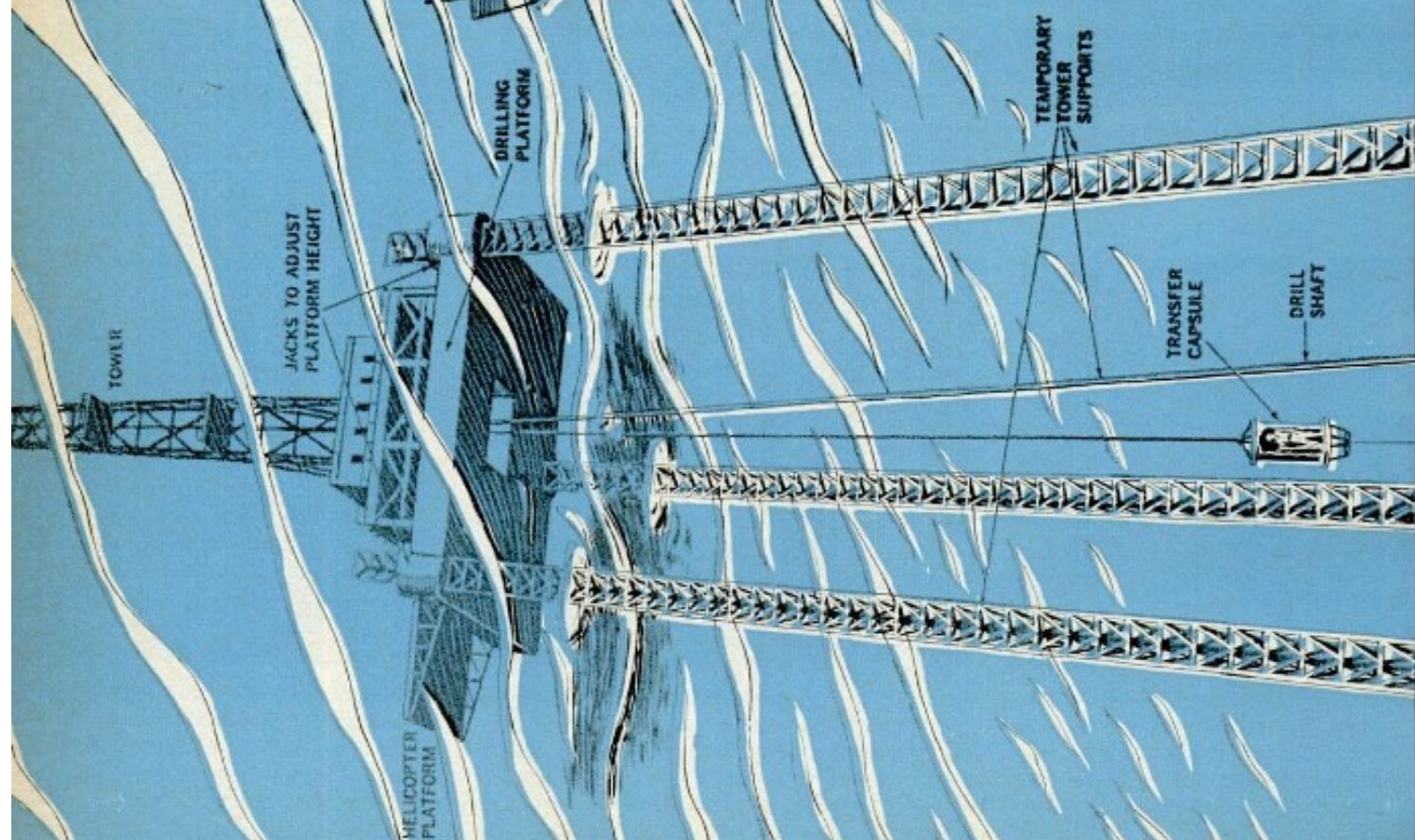
CBS is setting up a plant for high-speed duplication and will develop the EVR market through the television, publishing, and motion-picture industries. In license agreements with CBS, Motorola will manufacture EVR players and the New York Times will develop educational EVR cartridges.

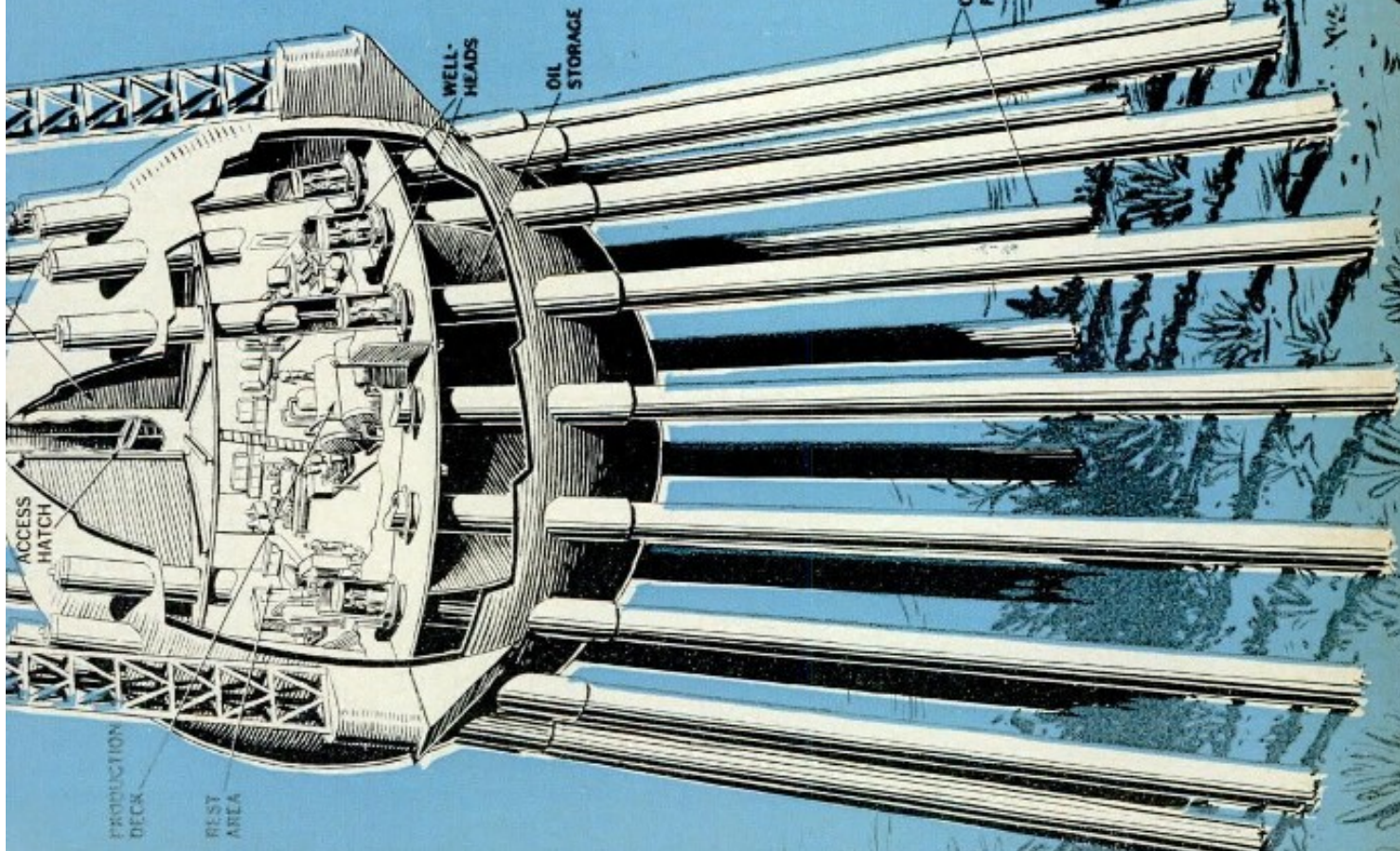
Although introduced in black-and-white, EVR will ultimately go to color. The initial price of a player is estimated at \$800, but without question, this new sight-and-sound recording and playback system promises to open new doors to gaining knowledge and enjoying entertainment at home.

PS

Oil-Gathering Octopus Under the Sea

DRAWING BY RAY PLOCH





■ surface to pump oil from up to 18 deep-water wells. Buoyant, it will be floated into position and then winched down beneath the waves by means of an anchor driven deep into the ocean bottom. One by one, steel pipes will be driven through 18 well slots around the sphere's circumference. Next, a temporary oil-drilling tower will be installed above the capsule to drill wells down through the 18 "legs." (The legs serve no supporting function but merely anchor the capsule; its buoyancy puts tension on them and supports the tower above it.) After the last wellhead is in place and a check made to insure that everything is working, the underwater "octopus" (sans tower and support ship) will be left, completely unattended, to gather oil.

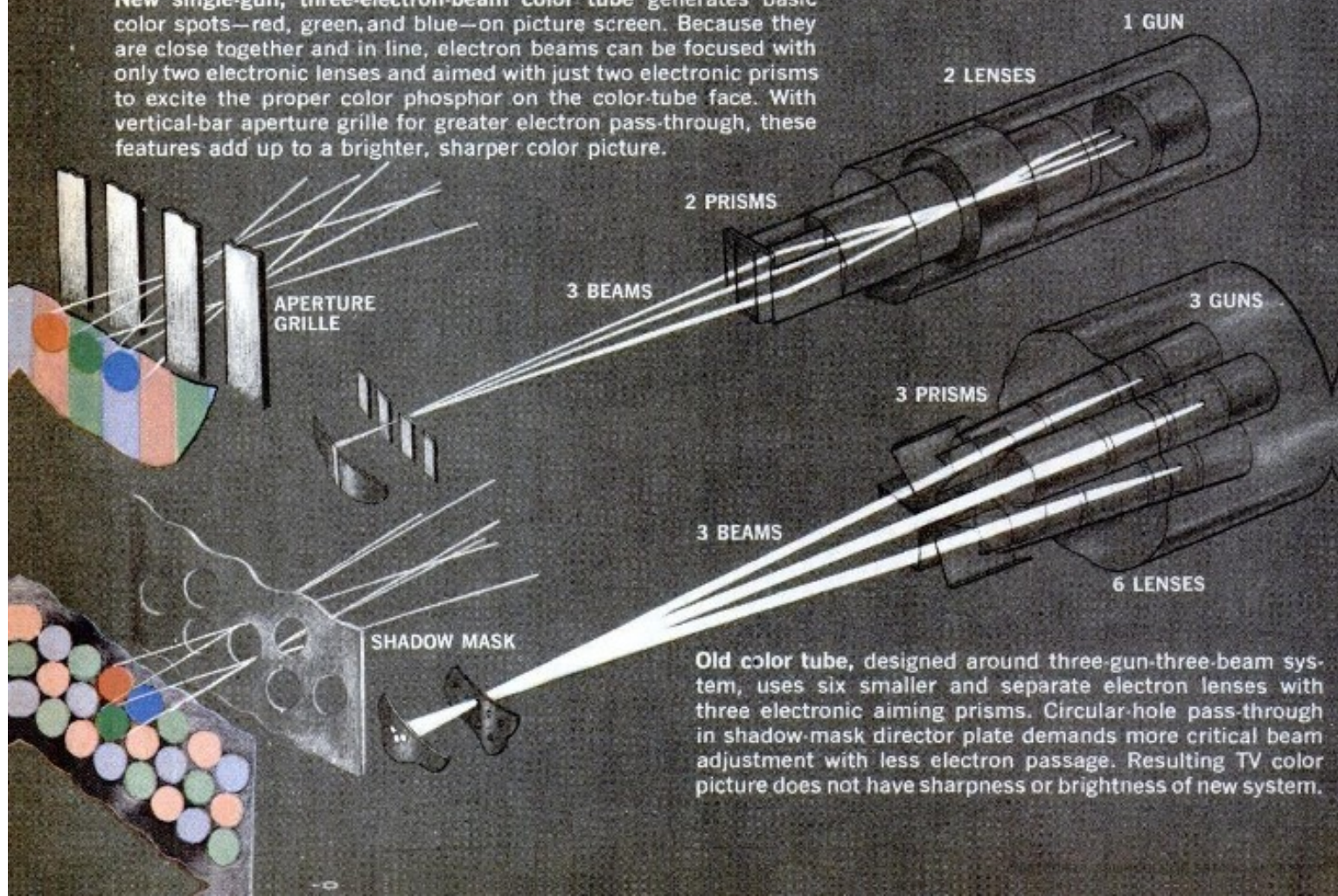
The invention of Ocean Systems, Inc., the capsule is habitable and will frequently shelter engineers and workmen—arriving via a transfer capsule—on its production deck. This deck, which contains compressors, pumps, computer, telemetry gear, power transformers, rest area, and life-support equipment, will be pressurized with a breathable, noncombustible oxygen-hydrogen-helium mixture. An emergency power supply and back-up life support are provided in case the regular power—delivered by submarine cable—should fail.

The 80-foot capsule (smaller models are also planned) can store 35,000 barrels of oil in its upper and lower sections. This will be transferred either to an ocean-going barge through a flexible pipeline attached to a surface buoy, or to a pipeline leading to shore. The sphere, sheltered from surface winds and waves, will eliminate any fire hazard, and, in ocean depths greater than 300 feet, will be much more economical than surface-drilling platforms.

New TV Color Tube Gives Brighter, Sharper Pictures



New single-gun, three-electron-beam color tube generates basic color spots—red, green, and blue—on picture screen. Because they are close together and in line, electron beams can be focused with only two electronic lenses and aimed with just two electronic prisms to excite the proper color phosphor on the color-tube face. With vertical-bar aperture grille for greater electron pass-through, these features add up to a brighter, sharper color picture.



Old color tube, designed around three-gun-three-beam system, uses six smaller and separate electron lenses with three electronic aiming prisms. Circular-hole pass-through in shadow-mask director plate demands more critical beam adjustment with less electron passage. Resulting TV color picture does not have sharpness or brightness of new system.

Color TV takes a giant step forward with this new single-gun picture tube. It will give you a higher-quality, smaller-size, simpler-circuit color set—and should reduce maintenance

By SAM SHATAVSKY / PS Electronics Editor

One electron gun in this new color-TV tube does the job of the three guns used in the standard color-receiver system to emit three electron beams. Each of these beams excites and lights up the appropriate red-, green-, or blue-producing phosphor on the tube face to generate the color image.

Developed by the Sony Corporation, the new tube, called Trinitron, claims some significant advantages:

- Brighter, sharper color picture with greater contrast.
- Simplified picture-tube construction in smaller space.
- Less-complex circuits with fewer chassis components.
- Easier picture adjustment in fewer steps.
- Reduced size and weight of set.

There is no mystery to the generation of three beams from a single gun. Sony's engineers have simply combined three individual beam-producing tube cathodes into one integrated gun structure. It's like combining three single-barrel shotguns into a triple-barrel gun.

The assembly of such a unit is something else. It's critical. But apparently Sony has mastered it.

To understand how the color tube does its job, you can think of it as you would an optical system. Just as optical systems depend on lenses and prisms to focus and direct light beams, so the color-TV picture tube relies on electronic lenses and electronic prisms to steer its three electron beams to the right color phosphor on the tube's viewing face.

The three beams from one gun have been lined up much closer together than separate beams from three guns. This permits the use of two large electronic lenses instead of six smaller ones. Since large lenses intercept a greater portion of the electron beam and have a more uniform beam-focusing field, this new

color-tube system yields a brighter and sharper color picture.

Besides that, the Trinitron's three beams are in an in-line, instead of triangular, arrangement. This simplifies tube-convergence adjustments—the process of directing the three color-producing beams to the same focal position at the viewing screen. In-line beams need only two adjustments compared with 12 in the old three-gun color tube. That should reduce TV service calls you have to make for convergence alignment.

Another Sony improvement is a new mask system, the Aperture Grill. The mask in a color tube is the color-selecting plate directly behind the tube's color-phosphor-coated viewing face. The new mask is a metal plate formed into vertical bars corresponding to vertical color-phosphor lines on the viewing-screen surface. (The old shadow mask uses a hole-perforated plate lined up with color-phosphor dots.) The Aperture Grill arrangement gives 30-percent more electron-beam transparency than a shadow mask, for a brighter color picture.

With these two breakthroughs, some spectacular color viewing is in store for this spring when Sony begins to ship sets equipped with the new tube.



Single-gun color tube (right) has smaller neck diameter with smaller wraparound sweep coil. It gives greater beam-sweep sensitivity, takes less power, and reduces the size and weight of the color set.

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For Popular Science's 100th anniversary issue in May, 1972, Wernher von Braun wrote a piece on the then-just-approved Space Shuttle project. Now, just over two years from first scheduled test flights, we decided with Dr. von Braun that it was time to look at the subject again, since considerable progress has been made over the past couple of years in the design of both the vehicle and its mission.

This second look at the Shuttle missed by a hair being a second kind of 100th anniversary—this one in the long and fruitful relationship between Dr. von Braun and Popular Science. His first piece appeared in the January, 1963 issue. For several years, his articles ran monthly. Finally, the burden of writing a monthly piece while simultaneously directing the development of the Saturn V rocket that was to land men on the moon in 1969 became too much, and Dr. von Braun suggested his pieces appear every other month instead.

In the 12 years that he has served as consulting editor for Popular Science Dr. von Braun has chronicled every aspect of the birth of the space age from the first feeble attempts to collect scientific data with unmanned probes through the continuing drama of manned space flight. It all adds up to an impressive body of work. The article on the space shuttle that begins on page 70 of this issue is the 99th that Dr. von Braun has written for Popular Science. His 100th—on next summer's joint Apollo-Soyuz mission in which American and Russian astronauts will rendezvous in space—will appear in January. And we're already well into the planning for his next 100 pieces.

Speed—does it really kill?

The news that traffic deaths dropped significantly early this year when the speed limit was reduced to save gas has been widely publicized. A lot of people who believe in the old saying, "speed kills," see a cause-and-effect relationship here. But research now shows that that may be far too simplistic a view. The Highway Users Federation points out that not only speed, but total travel was down by more than five percent during the first five months of the year. Tie this to the results of a National Safety Council study that analyzed traffic patterns for five national holidays in the 1970-72 period and found that traffic volume has a powerful

influence on the accident rate. In fact, an increase of four percent in the volume caused deaths to jump an astonishing 22 percent. So maybe it was the decline in volume and not the speed limit that lowered the death rate this year. Jan Norbye has some views on this subject and what we should really do if we want to save both lives and fuel. His column is on page 60.

Boats with wings

In August, consulting editor Ben Kocivar wrote about how exotic sails built like airplane wings are opening up a new era of advanced sailing technology. We picked a winner. Pictured in that story was Patient Lady II, a C-Class wingsail-equipped catamaran. Now, Ben has just returned from Los Angeles, where he watched the Little America's Cup challenger trials. Winner in four out of six races was Patient Lady III, with lighter hulls and an improved wingsail. Present plans call for her to race Miss Nylex—also wingsail-equipped and present holder of the International C-Class trophy—in Australia next year.

Brief followups

- Another step on the march into a metric future: Firestone has announced that a new factory now making brass-plated steel tire wire is totally metric. John Musch, a division president, said no one on the 250-man staff has had any trouble learning to handle metric measurements.
- The country's first solar subdivision—Vista del Colinas—in El Cajon, California, has its first two solar houses operating. And, says Robert Gallagher of Energy Systems, Inc., the company that installed the solar equipment, results are even better than expected. The goal was to save 50 percent of the fuel that would otherwise have been needed. But first tests indicate the savings will be 75 to 90 percent. The company is now starting to develop a solar-powered air conditioner.

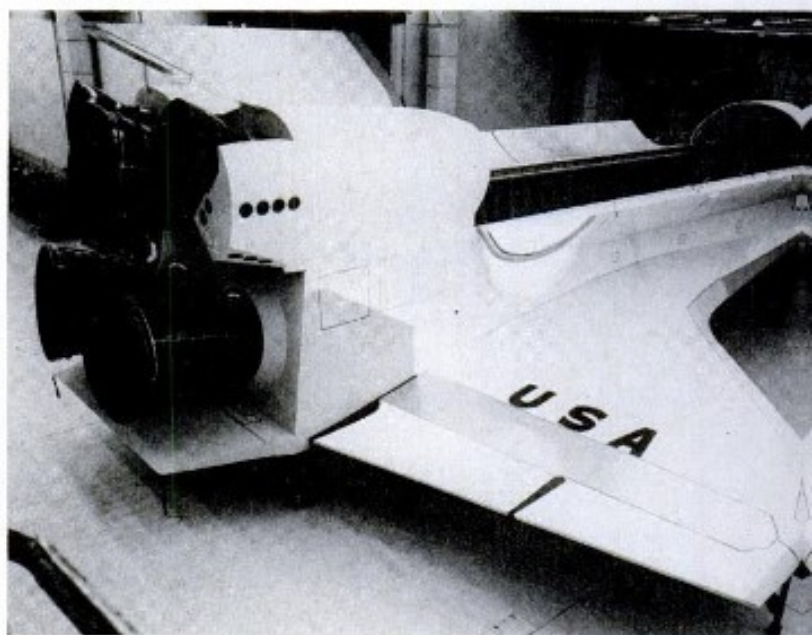
Hubert P. Luckett
Editor-in-Chief



Spectacular launch of Space Shuttle, with Orbiter and booster engines all firing, is visualized by Rockwell International artist. Twin boosters flank the Orbiter's huge external fuel tank.



Shuttle puts payloads in orbit 115 miles up—like earth-survey satellite, on manipulator arm, above.



Full-scale Orbiter mockup is shown with doors of great cargo bay open. Manned craft compares in size with that of a DC-9 jetliner.



Reusable space shuttle

...our biggest
bargain in
out-of-this-world
research

NASA is developing a vehicle that takes off like a rocket, moves into orbit like a spaceship, and returns to earth by landing like an airplane. The Shuttles will be our "railroad" into space in the 1980's

By WERNHER von BRAUN
PS Consulting Editor, Space

If you think our space program is rapidly going out of style, you are wrong. And if you believe that after the spectacular successes of Apollo and Skylab, U.S. space flights will henceforth be limited to unmanned activities, you are wrong again.

Starting in 1979, a new concept in the U.S. space program should drastically reduce the cost of space operations. For the following 12 years, from special launch sites at Cape Canaveral's Kennedy Space Center and Vandenberg AFB in California, manned *reusable* spacecraft will be rocketed into earth orbit.

During that period, some 725 launches, averaging about one a week, are expected. Bus-size payloads weighing up to 65,000 pounds—including weather, communication, earth-resource, military, pollution-control, scientific, and navigation equipment—can be carried into orbit by the Space-Shuttle craft now being developed for NASA by Rockwell International. If the payload is an unmanned satellite, the shuttle will return at once. If manned experiments are involved, the four-man flight crew and up to

six passengers may stay in orbit up to a month. The 83-ton, delta-winged vehicle is designed to survive scorching reentries through the atmosphere, landing like an airplane on a runway.

After landing, Shuttle craft will quickly be readied for another mission. Each vehicle can be orbited 100 or more times. This reusable aspect of the Shuttle program lowers the cost per flight to \$10.5 million. Orbital transportation cost for each pound of orbital payload will be about \$160, compared to \$500-\$1000 with conventional expendable rockets.

The Space-Shuttle program will include three basic types of missions for government agencies and universities, foreign countries, and commercial organizations:

- Manned scientific or earth-related application missions using a modularized spacelab that remains with the Orbiter.

- Transporting unmanned or man-tended spacecraft to low orbit, revisiting them for modifications.

- Tug missions for higher orbits and unmanned lunar and planetary missions. The tug, an extra-propulsion unit, will be carried with the payload in the Shuttle's cargo bay.

Preparing a launch

Prior to launch, the payload will be loaded in the cavernous cargo bay in the center of the Orbiter's body. The Orbiter is a DC-9-size, airplane-like vehicle with a 78-foot double-delta wingspan. The payload bay accommodates loads up to 60 feet long and 15 feet in diameter.

The Orbiter has three 375,000-

Continued



Author von Braun tries out copilot's seat in mockup of Shuttle's Orbiter.



Craft defies reentry heat

Most dramatic feature of Shuttle is its ability to emerge unscathed from repeated exposure to fierce heat of reentry—simulated above, with model of first

pound-thrust Rocketdyne engines, but the liquid-hydrogen/liquid-oxygen they consume is not stored in the vehicle. Instead, propellants are carried in a huge external tank—27 feet in diameter and 155 feet long. The Orbiter rides this tank piggyback into space, until, just before orbital altitude, the tank is jettisoned. Also, for the first stage of the launch, two solid-fuel rocket boosters of 2½-million pounds thrust each are side-strapped to the Orbiter's fuel tank.

A simulated mission

Here is what a typical low-orbit flight of the Space Shuttle will be like:

Before the countdown begins, the entire vehicle, 181 feet long and weighing 4.1 million pounds, is moved from a protective hangar to the launch pad on a treaded crawler transport.

The four flight crew members, commander, pilot, mission and payload specialists, are seated on tilt-able couches in the upper flight

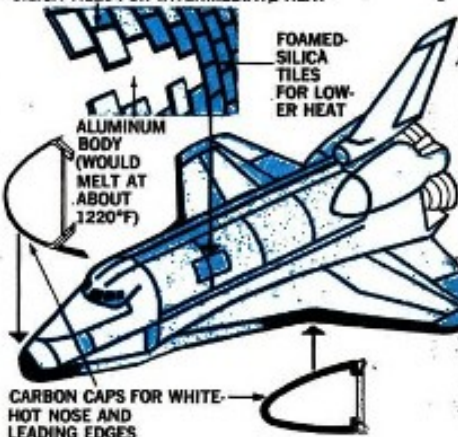
stage of an early, developmental design, in arc-jet facility at NASA's Ames Research Center, Moffett Field, Calif. New heat-defying materials replace expendable ablative ones to cover aluminum Orbiter—"carbon-carbon" caps over

deck. A lower deck has seats for six passengers, sleeping and eating quarters, sanitary facilities, and an assortment of electronics equipment. (The Shuttle will be the first space craft to have facilities for women, since they will no longer be excluded from space flights, according to NASA.) During the flight, passengers and crew experience relatively mild acceleration forces limited to three g's. Acceleration and deceleration forces exceeded six g's during Apollo missions, but the Shuttle is specifically designed to carry passengers who have not undergone rigorous astronaut training.

Liftoff occurs with the simultaneous thrust of the three main engines and two solid-fuel booster rockets. Aerodynamic controls, used later for reentry, are locked, and the vehicle is guided by changing the thrust angle of all five rockets. At an altitude of 27 miles and a velocity of 3210 mph, the solid boosters burn out. The casings are jettisoned and parachuted into the ocean for recovery and reloading.



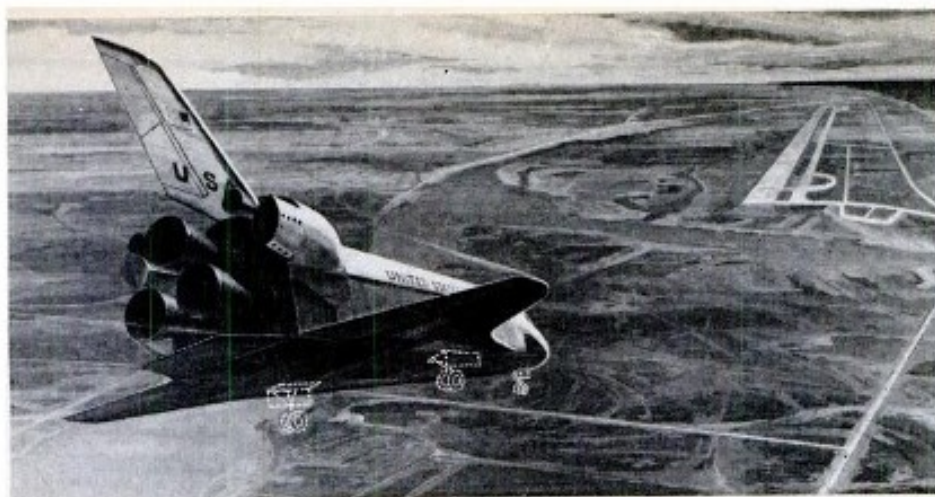
SILICA TILES FOR INTERMEDIATE HEAT



white-hot nose and wings' leading edges, and silica tiles over rest (diagram, lower right). At reentry, tile-sheathed craft pitches nose-up (upper right) to limit temperatures at hottest spots, and does a "belly-whopper" into atmosphere.

Meanwhile, the Orbiter's three main engines push it ahead. As the vehicle ascends into the vacuum of outer space, each engine can deliver 470,000 pounds of thrust. At a velocity of 17,600 mph, while moving almost horizontally at about 115 miles up, the main engines are shut off and the external tank is jettisoned. At this suborbital speed, the tank will reenter the atmosphere and burn up like a shooting star.

At this point, two 6000-pound-thrust engines for the Orbital Maneuvering System (OMS) provide the power burst required for a stable orbit. The OMS engines are attached to either side of the Orbiter's rear fuselage. Additionally, the vehicle's Reaction Control System (RCS) provides forty 900-pound-thrust rockets and six 25-pound-thrust vernier rockets for altitude control in orbit and during the early reentry phases. With a full 65,000-pound payload, a due-east orbit of about 240 miles is possible. Replacing payload weight with extra propellants for the OMS en-



Back to earth at 215 mph

Safely past reentry, pilot heads for a more-than-200-mph touchdown on runway, top view—and lowers wheels (dotted lines) just before reaching it.

gines permits higher orbit missions.

Once in orbit, the commander and pilot leave their forward-facing seats and move to control stations that face the rear. The pilot opens the payload doors while the commander maintains the Orbiter's attitude. Riding behind the pilot is the mission specialist, who now swivels his couch to a nearby panel and monitors critical payload services—electrical power, cooling, fluids—the Orbiter must supply to the payload. Finally, the payload specialist activates the experiments and monitors all of the payload's subsystems and the quality of the collected data.

Crew and passengers will work in shirt sleeves, in an atmospheric environment much like that on earth. Cabin air is a nitrogen-oxygen mixture at a sea-level pressure of 14.7 pounds to the square inch. (Apollo crews used pure oxygen at 5 psi.) Heat-stabilized and freeze-dried foods, as well as advanced personal-hygiene facilities, bring the comforts of home to the Shuttle.

After landing, craft will be towed immediately to special hangar for servicing, as below, to prepare it for another mission. Quick turnaround aims to have each of Shuttle fleet ready to fly again within two weeks of its return from space.

Electrical power is furnished by three 12-kilowatt hydrogen-oxygen fuel cells.

Launch pad in the sky

For missions using a modularized spacelab loaded in the bay, the dual payload doors are first swung open. This offers a clear view for the spacelab's astronomical or earth-viewing instruments. Spacelab equipment is mounted on an open pallet forming the aft portion of the lab. Its front end has a drum-shaped, pressurized room used by scientists for observation and instrumentation control.

The spacelab, to be specially equipped for each mission, is being funded and developed by the European Space Research Organization. Prime contractor is Entwicklungsring Nord (ERNO) of Bremen, but there are associate contractors from several other European countries.

The Shuttle will also transport unmanned satellites into orbit and leave them behind. After the pay-

load doors are opened, long mechanical "manipulator arms" lift the spacecraft from its berth. Outside, but operated from within the shuttle, crucial spacecraft subsystems such as solar arrays, antennae, attitude controls, sensors, and transmitters are deployed, activated, and monitored. The spacecraft is released only after ground stations report that they receive a good data stream. Faulty spacecraft can be returned to earth for repair.

Shuttle craft will also have rendezvous and docking capabilities, enabling them to revisit complex spacecraft such as the upcoming Large Space Telescope (LST)—an orbiting "Palomar in the Sky." Such a valuable instrument must be designed for several decades of useful life. But since no one can predict the most interesting science objectives that far in the future, manned visits will be necessary between major science assignments for updating, reprogramming, and changing equipment. The LST will be unmanned between visits.

A docking module placed in the Shuttle's cargo bay would enable personnel to move directly from the pressurized crew compartment to the LST's pressurized instrument module. For high orbits or unmanned lunar and planetary missions, spacecraft carried in the Shuttle's bay will have propulsion units called "tugs" attached to them. After arriving in a low orbit, the tug/spacecraft combination is lifted from the bay. The shuttle then withdraws to a safe distance and the tug engine is ignited, boosting the spacecraft into higher orbit or into an escape trajectory.

Tugs will be used to reach the 23,200-mile geosynchronous orbits in which satellites match the earth's revolution and thus appear to stand still. Future high-energy tugs may lift 8000-pound spacecraft into synchronous orbits. Yet the total launch costs for such missions, some \$15 million apiece, is less than half those of a Titan IIIC rocket, which is limited to payloads less than 4000 pounds.

Before a special high-energy tug is built, however, three proven upper stages of existing rockets may serve as interim tugs. One is the Titan IIIC's "transtage," specifically designed to boost payloads into higher orbits. Two other possibilities are the Agena and Centaur stages.

A modified version of the Shuttle can also be used to loft very heavy payloads for special missions. In this

[Continued on page 136]

Geothermal energy

...the prospects get hotter



Initial flow testing at a wellhead in Imperial Valley by the Dept. of the Interior. Well is 6005 ft. deep; initial bottom temperature: 369° F.

Tapping the earth's heat as an energy source is coming on stronger than ever

By JOHN F. HENAHAN

Today everyone agrees that geothermal energy is an abundant and essentially unlimited power source. The only problem: devising systems that can turn it into electricity, and do it efficiently.

All early geothermal fields—such as those at the Geysers in California; in Lardello, Italy; and in New Zealand—are so-called dry-steam reservoirs. But those are rare: They exist only where a supply of underground water comes in contact with cracked hot rock and is turned into steam. Where this happens, it's simple to get geothermal electricity; just drill a hole and pipe the natural steam to a nearby turbine.

But there are two other potential sources of geothermal power, and these are plentiful: hot water and hot dry-rock deposits. Enormous amounts of energy are stored in such reservoirs—but it's not so easy to get it out. Some hot-water deposits—such as the vast reservoir that underlies California's Imperial Valley—are not pure water but violently corrosive brines that can clog up drill holes or eat out machinery in days. Getting energy out of hot dry rock presents considerable difficulties of its own.

All the experts agree: Before we can get really large amounts of energy from the earth, we'll have to solve a lot of tough technological problems involved with hot water

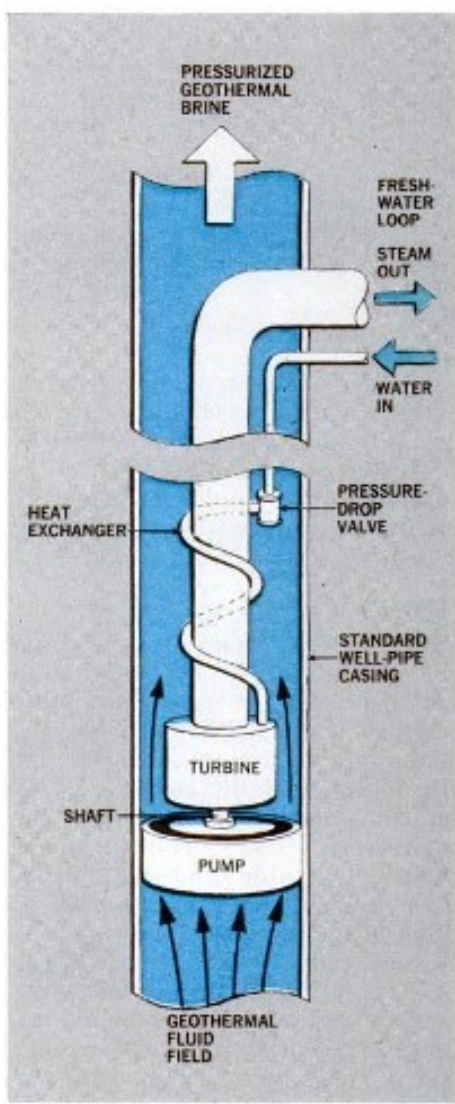
and hot dry-rock fields. I've just been talking with some of the research teams at work in these areas. I found that they're coming up with a lot of ingenious solutions, and that they're excited about the prospects of geothermal energy. As they talk, you can sense the potential payoff that excites them.

Fantastic amounts

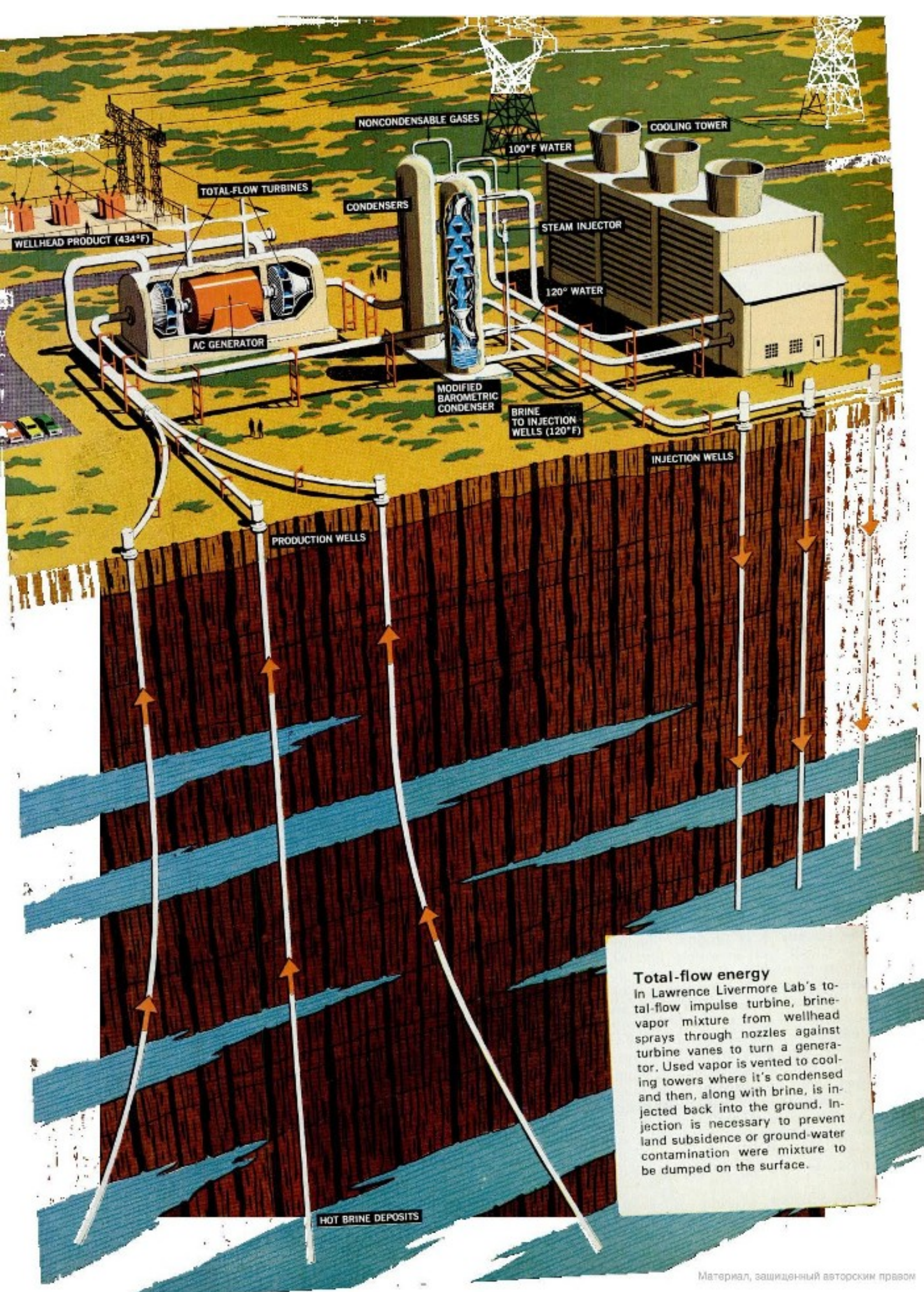
Dr. Don White, of the U.S. Geological Survey in Menlo Park, Calif., estimates that the heat in the top 10 miles of the earth's crust totals 3×10^{21} calories. That is about 2000 times the amount of heat that would be produced if we burned the world's entire supply of coal. Much of that heat is so spread out or so deep below the earth's surface that it defies commercial exploitation. It has been estimated, however, that if only one-tenth of the geothermal energy in the top two miles of the earth's crust could be extracted by today's techniques, and converted to electricity, it could provide 58,000 Mw annually for at least the next 50 years. Dr. Robert Rex, president of Republic Geothermal in Whittier, Calif., and one of the foremost pioneers in the field, estimates that there is enough energy sealed beneath the Imperial Valley alone to meet the electrical needs of the Southwest for at least 200 years.

A report issued by a committee headed by former Secretary of the Interior Walter Hickel estimates that it should be possible to develop as much as 132,000 Mw of geothermal generating capacity in the United States by 1985. On the other hand, the more conservative Na-

Continued



In Sperry Rand's down-hole pump, water is forced down well in narrow pipe to point where geothermal brine would flash into steam (1200 to 1700 feet down). Water passes through pressure-drop valve to heat exchanger where it turns into steam; steam drives turbine that in turn drives pump. Pump then forces geothermal brines to wellhead for use in the power plant's turbines.



Total-flow energy

In Lawrence Livermore Lab's total-flow impulse turbine, brine-vapor mixture from wellhead sprays through nozzles against turbine vanes to turn a generator. Used vapor is vented to cooling towers where it's condensed and then, along with brine, is injected back into the ground. Injection is necessary to prevent land subsidence or ground-water contamination were mixture to be dumped on the surface.

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The **What's New** magazine

®

Here at last:
**VIDEO-
DISC
PLAYERS**

**Strange world of
SUPERPRESSURE**

**SECRETS OF
SHARPENING**

**BIG BOATING
SECTION:**

- Ski-hull boat
- Windsurfing thrills
- Kevlar replace fiberglass?
- '77 outboards
- Hot cats
- Cuddy cabins
- Marine CB

**ICE-BLOCK HOUSE
cools with
winter heat**



TV PICTURE
SIMULATED

Here at last— video-disc players

Two disc machines that let you program your own shows will be introduced in '77

By JOHN FREE

Sometime this year, TV viewers in selected areas of the country should be able to schedule their own shows in an entirely new way. They'll select movies, musical performances, or other material on video discs, slip the discs into players wired to their receiver's antenna terminals, and push a button to watch the show.

A long list of glittering new video players has been promised, postponed, or introduced in recent years, only to fade from sight. But there are definite signs that at least two major worldwide organizations with the financial muscle and marketing know-how to succeed will begin selling their video-disc players regionally in 1977.

One of them, RCA, is already field-testing a few hundred of its capacitance-sensing SelectaVision disc players. N.V. Philips, the Dutch firm that brought us the standard audio cassette, and MCA Inc., an American entertainment-oriented firm, also plan to offer an optical video-disc system this year.

The latest price estimates: about \$500 for the player, and \$10 to \$18 for a disc or set of discs.

There's even a possibility that a Japanese licensee of a British and German disc venture, the grooved-disc TED system [PS, Nov. '74], could be marketing disc players, too. Players for 10-minute TED discs have been available in Ger-



many since 1975, although only for European TV-signal standards. Sales have been poor. A TED changer that handles 12 discs was recently shown. Spinning on the sidelines are other disc systems still under development [see box: "In the labs: machines that record and play discs"].

Both the RCA and Philips/MCA players will appear in stores just when new home video-cassette recorders [PS, Dec. '75], video games [PS, Nov. '76], and pay-cable programming are teaching viewers that their TV receivers can easily display something other than fixed-time broadcast fare.

What's different about the new disc hardware and programming?

A technician slides a SelectaVision video-disc player into its outer cover at RCA's new plant in Indianapolis.

After operating both the RCA and Philips/MCA players, trying some amazing manipulations of TV images, and listening to stereo hi-fi TV sound I found that the new machines offer spectacular gains in performance compared with other home program sources.

Stamping out tons of discs at low cost is the biggest advantage of the new medium. Both Philips/MCA and RCA expect to offer a broad selection of discs when their players appear. MCA, which will manufacture most U.S. discs for the Mag-

Continued

navox-built player, plans 1000 albums initially.

MCA discs will include new and old films, ballet, opera, theater, sports, how-to and children's programs, and documentaries. MCA can also make a thin flexible disc that might be inserted in periodicals. Discs may also be distributed as entire magazines, catalogs, or talking encyclopedias.

Also, a variety of independent companies will add other special-interest discs to catalogs. One firm, Visiondisc Corp. of New York, for example, planned to tape last year's Christmas services and works of art at a large cathedral for transfer to discs.

Here's how the two leading players and disc formats differ:

RCA's SelectaVision

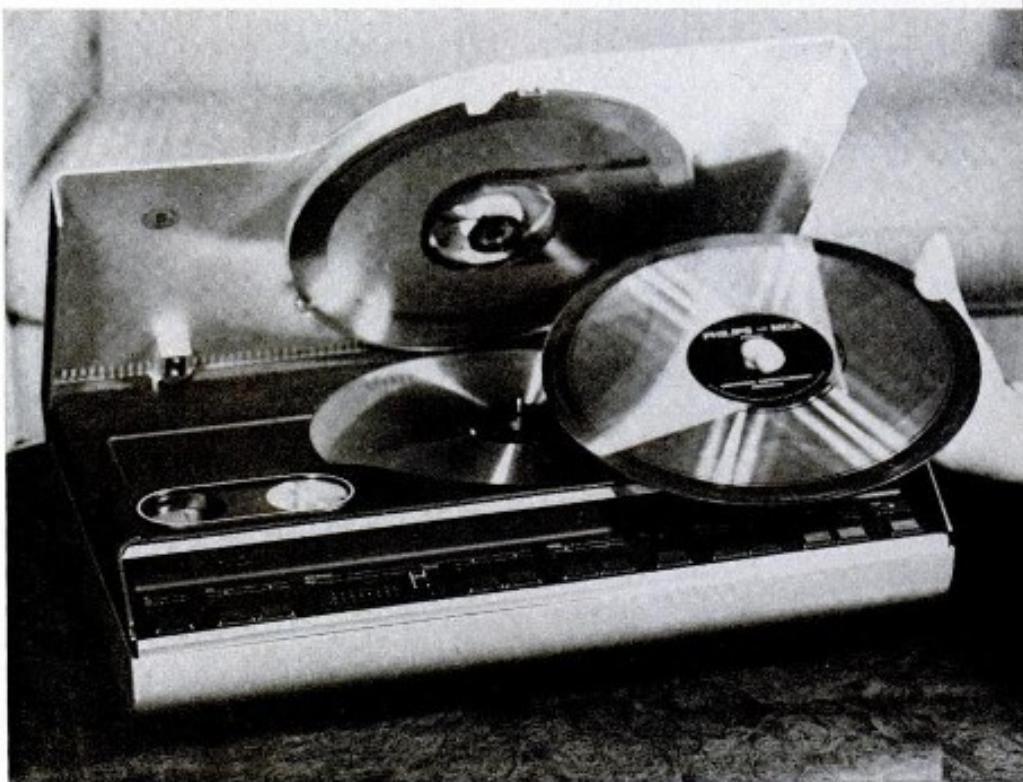
This machine is designed to play a rigid, grooved disc 12 inches in diameter and programmed on both sides with 30 minutes of material. The function of the spiral groove is to guide a stylus, much as in an audio-disc system.

But that's the end of any similarity to familiar 33-1/3- or 45-rpm discs. The SelectaVision player, which won't operate unless the lid is closed, spins discs at 450 rpm. TV signals are encoded as minute rectangular depressions at the bottom of each groove. The slots vary in spacing and width, with some as narrow as 0.25 microns (millionths of a meter). RCA devised a method of producing the slots on a disc master, using a sharply focused electron beam, since required widths are too narrow to be generated optically with light. The discs have a vinyl base topped with thin layers of metal, an insulating plastic (dielectric), and an oil lubricant that reduces stylus wear.

Together, the disc and metal-tipped stylus form an electrical circuit. As the slots spin past the stylus, tiny abrupt changes in circuit capacitance occur. These changes detune an oscillator circuit to produce the TV signal.

To compensate for small changes in rotational speed, a tiny transducer, which functions somewhat like a loudspeaker coil and cone, stretches the stylus arm back and forth parallel to the groove. Errors in speed are detected by monitoring the recorded color-burst signal.

A close look at a SelectaVision player confirms RCA's disc-system-design philosophy. Components are housed in a simple, inexpensive cabinet with a minimum number of controls. Internal circuit boards and



components, prominently displayed on a pegboard in RCA's New York demonstration room, remind you of a Heathkit spread out for assembly. RCA deliberately designed a player that could be easily mass-produced with relatively standard parts.

Care is necessary when loading discs in the machine, since fingerprints or smudges can create interference. Playing discs repeatedly through can remove contaminants from the grooves, but since the \$15 stylus must be replaced after 200 to 300 hours of use, it's wiser to take good care of records. Each disc can be played about 500 times.

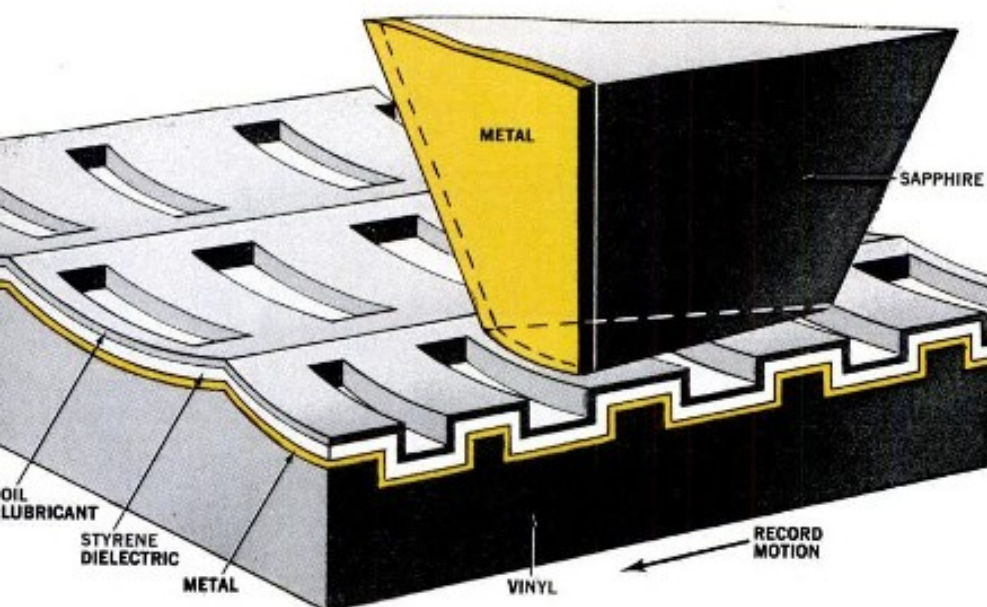
Pictures I've seen at several demonstrations were excellent. You

can rapidly move the tangential stylus arm forward or backward to selected disc areas by pushing buttons; a lighted index on the panel becomes larger or smaller. A pause button breaks stylus contact. The player has two audio channels for stereo or bilingual programming, and audio output jacks for optional connection to a hi-fi amplifier.

Philips/MCA player

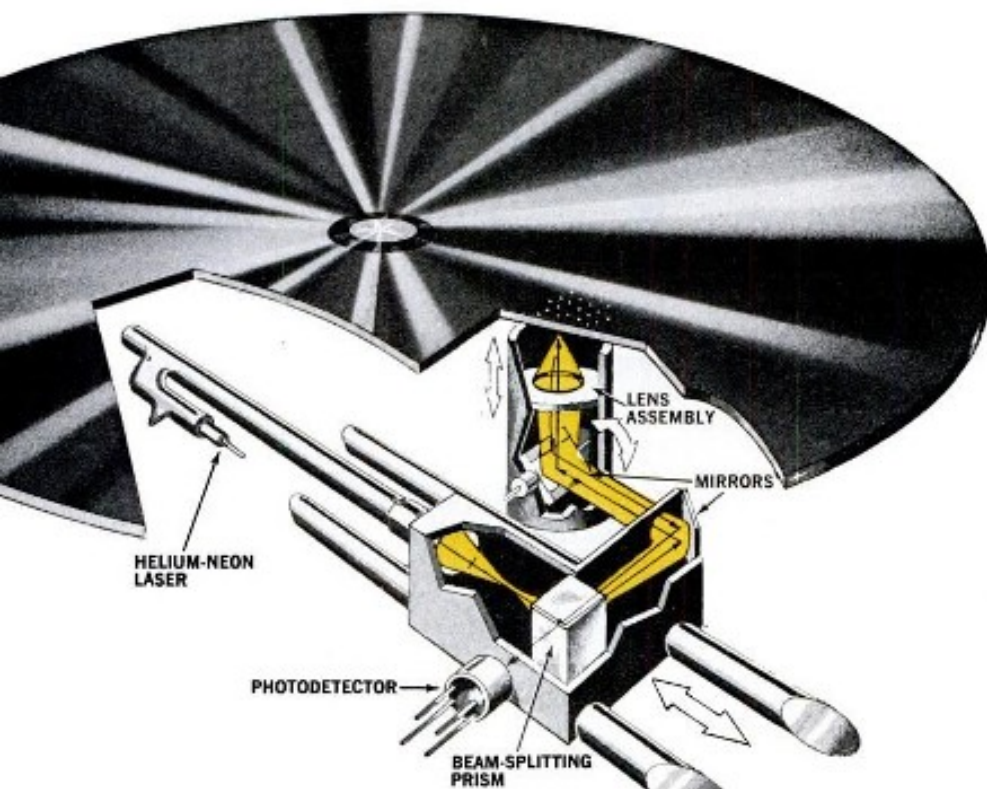
This concept differs radically from SelectaVision. Only the center spindle touches Philips/MCA discs as they spin at 1800 rpm. An air bearing that develops at that speed aids stabilization. A low-power laser

[Continued on page 140]



A stylus that detects picture signals in grooves

RCA SelectaVision player (far left) spins rigid 0.07-inch-thick discs at 450 rpm. Discs carry 30 minutes of material on each side. TV signals are detected by a metal-tipped sapphire stylus tracking at about 50 milligrams in a spiral groove. Picture information is recorded on discs as microscopic slots of different width and separation. The metallic stylus senses a change of electrical capacitance as the slots spin beneath it. This capacitance variation changes an electronic signal that is unscrambled into TV pictures. Metallic and dielectric coatings necessary for playback give SelectaVision discs a shiny appearance. There are 5555 grooves per inch, and each circular groove stores four 1/30-second TV frames. The player has fast-forward and reverse buttons for cueing.



Laser-beam system decodes a spiral track of bumps

Philips/MCA optical video-disc player (far left), manufactured by Magnavox, rotates discs at 1800 rpm. Players can handle either rigid 0.04-inch-thick discs, or, with an adapter, 0.007-inch flexible versions. Nothing contacts the disc for picture readout: A laser beam is focused through a mirror/lens system onto a spiral track of bumps on the bottom of the disc. Spacing between the bumps varies according to TV picture information. The bumps scatter the beam, but the flat, shiny aluminum area between them reflects light back through a two-way prism or mirror to a photodiode detector. The detector circuits convert the code-like flashes from the disc into a TV signal. Tracks are less than two microns (millionths of a meter) apart. The player can endlessly freeze a TV frame, show fast or slow-motion pictures, and display on the screen the number of up to 54,000 separate coded frames. Discs hold 30 minutes of programming on one side only.

In the labs: machines that record and play discs

As the big contenders (RCA, N.V. Philips, and MCA, Inc.), gear up production lines to produce capacitance and optical video-disc systems (diagrams above), other companies and institutions are busy refining other ingenious disc systems in laboratories. Although developers of new players frequently say they plan to market them, the huge expense of manufacturing and distributing a major new product today may prevent you from ever seeing most new systems in stores. Some of these disc systems are intriguing because they can record TV programs as well as play prerecorded discs:

- A magnetic disc recorder (MDR) has been under development for several years by Erich Rabe, a German record manufacturer [PS, Nov. '74]. The latest version, demonstrated last year in Europe, presented poor color pictures. Meanwhile, a U.S. licensee, TV Disc Corp. in Waltham, Mass., is developing its version of MDR. The Rabe recorder/player, similar in appearance to an audio turntable, has a tone-arm-mounted recording head that rides in the grooves of the magnetic disc. The head can record 24 tracks in the groove walls, and might provide two-hour discs. Early 12-

inch discs of this type played at a slow 156 rpm.

- Another disc-recorder system, developed by University of Toronto professor John Locke and a graduate student, encodes TV signals onto a specially formulated plastic with a low-power laser beam. Locke told the trade weekly, *Television Digest*, that he expects a home video-disc recorder would use a dual-power laser. The higher-power beam—perhaps only two milliwatts, or twice that of the Philips/MCA readout laser—would record, and the low-power beam would play back. Locke says he is in touch with potential manufacturers.

- In Japan, Hitachi Ltd. has developed a holographic video disc (playback only) that eliminates the complex focusing and tracking devices used in other optical systems. (Holograms are photographic images made with laser light.) The disc system, described in the June, 1976, *Applied Optics*, employs a continuous train of one-millimeter-square holograms on the disc's surface. Each hologram is actually three separate images (for brightness, color, and sound) offset 120° from each other. The disc rotates at only six rpm.

DECEMBER 1977 \$1.00

Popular Science

The **What's New** magazine

DAMADIAN'S SUPERMAGNET

How he hopes
to use it to
detect cancer

Ram-wing X-114

floats, skims, and flies



How 914-MPG CAR won
super-mileage contest

Big sound from those
new MINI-SPEAKERS

New DIGITAL WATCHES
do more than keep time

SOLAR PONDS: heat
from a hole in the ground

PS guide to
FIRE EXTINGUISHERS

Your car: a pro tells you how
to make BODY REPAIRS

Maxepman, gauvuturman, pppp, npsow

I won't settle for anything less than taste.

A lot of cigarettes promise taste.

But for me, only one cigarette delivers. Winston.
I get real taste and real pleasure every time I light up.
I won't settle for less. Would you?



Warning: The Surgeon General Has Determined
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Winston King Winston 100's..

Ram-wing X-114

floats, skims, and flies



Zippering above the waves at 90 mph, it saves fuel by flying on a cushion of air

By BEN KOCIVAR

When I first saw models and an early flying version of the ram-wing plane in Germany several years ago, I wondered why they didn't simply call it a flying boat. As the pictures on these pages show, it has a hull, it floats, it has an unusual wing, and it flies. But after talks with pilots and designers of the strange-looking craft, I learned that while it is in fact a flying boat, it also is something more.

The ram-wing plane, or aerofoil boat, is designed to fly most efficiently close to the surface. Thus it takes advantage of a phenomenon called ground effect. Such a vehicle can move people and freight over water faster and cheaper than hydrofoil boats or surface-effect ships [PS, June '74] using less fuel than high-flying aircraft.

Land hopping

Aerofoil boats can also fly over land areas where it is not economical to build expensive highways or rail systems; taxi in water like an ordinary displacement boat to maneuver at slow speeds in harbors; and plane at high speed, just touching the surface like a fast hydroplane. The latter technique is useful when visibility is poor, or when it might be necessary to make quicker stops than would be possible if the vehicle were airborne. Takeoff speed for the latest aerofoil design from West Germany

(the X-114) is 40 miles per hour and cruising speed in the ground-effect flight envelope is 90 mph.

What makes it work?

Every time an airplane takes off or lands, its wings build up dynamic air pressure between the plane and the earth's surface, creating a ground effect. The plane rides on a cushion of higher-pressure air. For the aerofoil, this dramatically improves the lift-to-drag ratio by as much as 250 percent. As a result, ground-effect flying requires much less power than flying at altitudes above or out of ground effect. Ground-effect flight also takes much less power than trying to zip along rapidly on the water surface. Ground effect usually becomes evident at altitudes of about half a plane's wingspan. The most desirable altitude, I was told, is about one-quarter the wingspan.

Ground-effect flight is not a new idea. A theoretical study of the concept was developed as early as 1921. And some conventional planes have actually flown with ground effect, at least some of the time. For example, I recall flying seaplanes over the Hudson River with the floats barely off the surface. I would start with power settings that permitted me to make very slow descents from altitude toward the water. Then, as I got into the denser air or the ground effect created by the wing close to the surface, the plane would keep flying effortlessly, never actually touching the water. It was an incredible floating kind of ride.

Extending range

In the 1930's, Lufthansa pilots

flying over the South Atlantic cruised long distances in this surface effect only a few feet above the water. They not only doubled their range but also gave their passengers an extremely smooth flight. During the war, crippled planes used this technique to stretch their remaining fuel and get back safely when their engines could not put out enough power to fly at altitude.

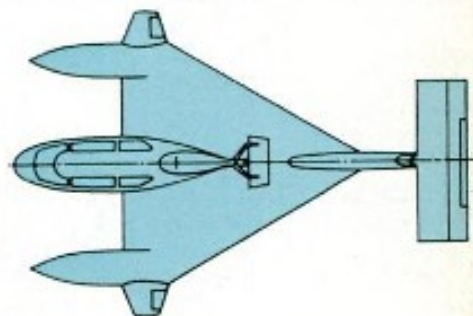
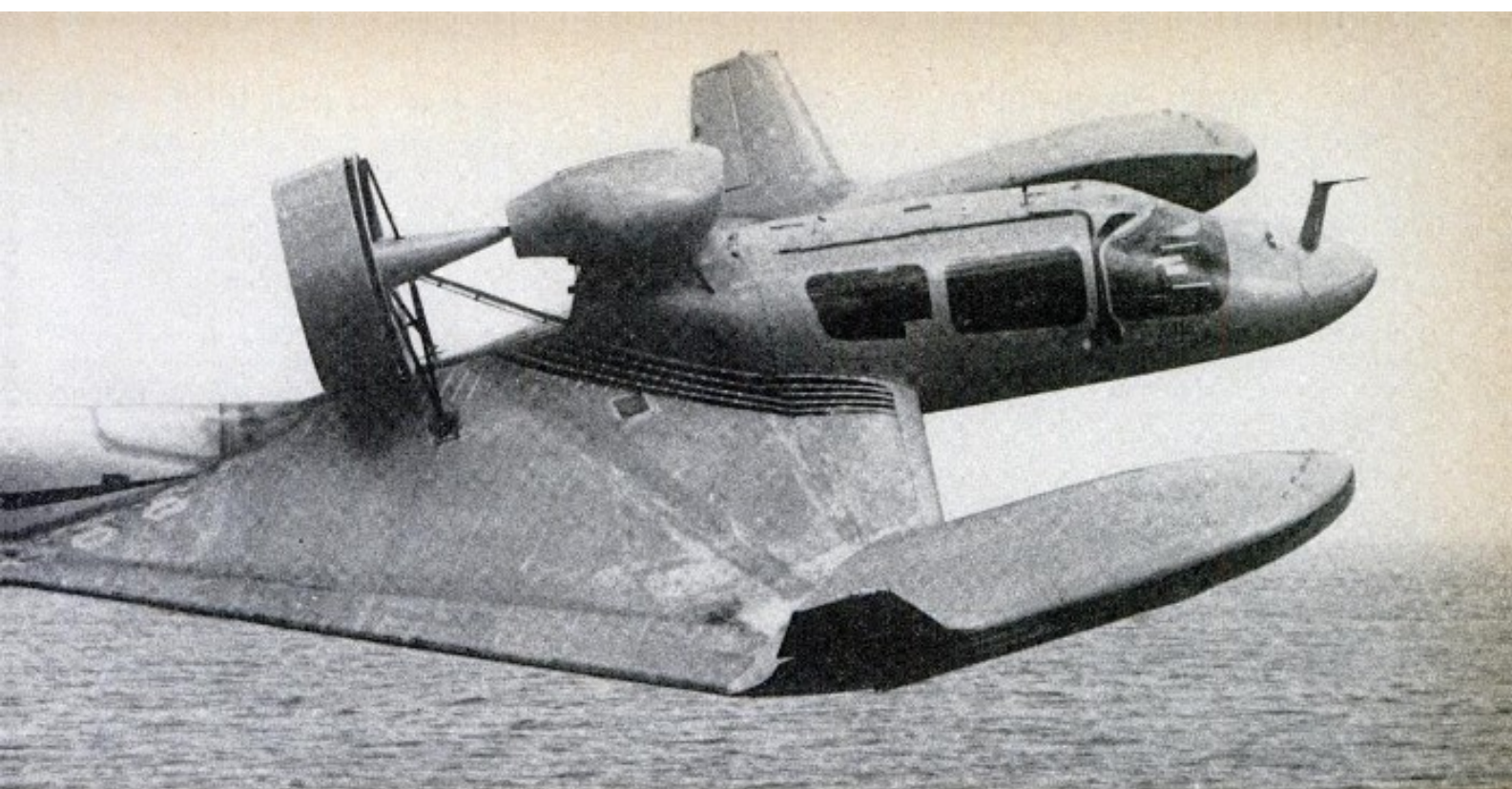
Hanno Fischer, a designer and test pilot for Rhein-Flugzeugbau GMBH who helped build and has flown the newest aerofoil boat, the X-114, told me the craft has a lift-to-drag ratio (L/D) of eight in free flight. This improves to 20 near the ground. Eventually he hopes to achieve 25.

What does this mean in comparison with conventional power planes? "It means we can fly a 3000-pound craft at 70 mph in ground effect with only a 70-hp engine," says Fischer. A comparable conventional plane, such as the Grumman American two-seater Traveler, weighs about 2000 pounds and requires a 150-hp engine for free flight at about 140 mph. Quite a power difference. And quite an additional fuel requirement.

First aerofoil

The career of Dr. Alexander M. Lippisch, who died in Iowa, was long and varied. Born in Munich in 1894, he helped design zeppelins, innovative sailplanes, and tailless supersonic delta-wing planes. He led the team that developed the rocket-powered Me-163B, the fastest military plane in World War II.

Continued



Hovercraft-like plane has a reversed-delta wing (diagram) with a shallow cavity beneath it that provides ground-effect lift at very low heights. Air cushion created during flight enables the X-114 to skim economically only a few feet above land or water. It can leap over low-lying obstacles and also fly like a conventional plane. A pusher prop gives it a cruise speed of 90 mph, with a 1200-mile range. The experimental craft was made in Germany by Rhein-Flugzeugbau.

X-114 flyer: "To jump over a ship, the pilot only has to pull back on the

After the war Lippisch worked for the U.S. Air Force and Navy. In 1959, when he was with Collins Hydrodynamic Laboratory at Cedar Rapids, Iowa, he started developing and flew his first aerofoil boat, the X-112. He conceived it as an "aerodynamic surface-effect, or ram-wing, vehicle," and considered it the best solution for a general-purpose medium-speed transport over waterways. In 1967, the West German Defense Department became interested and awarded contracts for further development. This resulted in the X-113 single-seater and the present X-114, a 40-foot-long seven-seater with a 22-foot wingspan. Current development is being done by Rhein-Flugzeugbau, an affiliate of VFW-Fokker, the same company that is developing the Wankel-powered Fanliner and Fantrainer [PS, March].

I learned some intriguing things about this unusual machine from technical papers and interviews with German pilots and engineers who have flown the plane.

The delta-wing design of the Lippisch aerofoil is most unusual; unlike other delta-wing planes, this one uses the straight side of the triangle as the leading edge, while the other triangle sides taper to the fuselage in the rear. Also, the wings droop dramatically, with float pods terminating the wing tips.

"The reverse delta shape does several things," said Hanno Fischer. "Most important, it provides longitudinal stability. On conventional wings the center of pressure [which provides lift] shifts forward from 45 percent of the chord [or cross section] when the wing is in ground effect to 25 percent at higher altitudes. This shift prohibits practical use of the ram-wing principle for surface-effect vehicles. The reverse delta with negative dihedral [droop] avoids this shift."

Flying high

I had heard that the earlier X-113 had flown not only in ground effect but also at altitudes of up to 2000 feet. How does it get this kind of power?

According to Fischer, the aerofoil needs more power to take off from the water and overcome water drag than it needs to maintain flight just above the water. For normal flight, the engine is throttled back to conserve fuel. Because it has this extra power to get off the water it can also hop up over obstacles such as built-up land areas, low mountains, snow, mud, ice—or ships.

"To jump over a ship, the pilot only has to pull back on the control wheel," says Fischer. "It can hop 66 feet high without trouble. Then you just level out and let it settle back automatically to its former altitude close to the water."

Flying at altitude, of course, requires additional power—and the loss of fuel conservation.

The reverse-delta shape and negative dihedral give other benefits, too. When the boat is in the water, only the small trailing tip of the wing is immersed. This creates much less drag than a conventional delta platform in which the whole trailing edge of the wing would be in the water. At the same time, the negative dihedral makes an immediate "air tunnel" under the wing that gives lift as soon as forward motion begins during takeoff.

The compact delta shape also provides structural advantages. Normally, good lift-to-drag ratios are best obtained by long slender wings like those of high-performance gliders. However, as lift increases, so does induced drag. Because the aerofoil is used in denser ground effect, much of the lift is provided by "pressing" on the ground. This lift, about 35 percent of the total, pays no penalty in induced drag.

Lighter wing

As a result, the aerofoil wing can be a relatively narrow, compact, stronger, and lighter wing providing more lift with less power.

Fischer described another interesting advantage. The aerofoil is absolutely stable. Once the correct altitude has been established, the craft holds altitude automatically—it can be flown hands off. To make landings, a pilot just reduces power

and the plane comes down and flares (levels off) automatically.

The aerofoil is amphibious. Retractable landing gears fold back into the wing-tip floats. These can be lowered one at a time to help make turns when the craft is afloat on the water. There is also a tail wheel. There are no water rudders.

The ducted-fan, 200-hp reciprocating engine of the X-114 has a reversible-pitch prop. Thus the craft can be braked or even moved backwards when it is on the water.

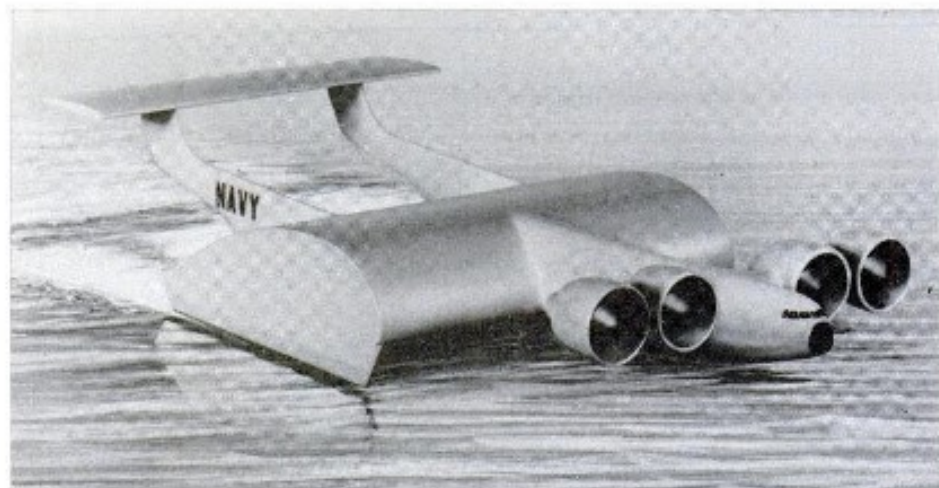
Flight controls are conventional, with dual control wheels and rudder pedals. The instrument panel has one unusual item: An extremely sensitive radar altimeter can measure altitude over average wave heights to within two inches. It can also be set to measure absolute height over the water surface.

Winglet controls

The plane has unusual small winglets that stick up at angles from the wing-tip floats. Although these look like the NASA winglets designed to reduce wingtip vortex [PS, Sept. '76], they are actually the aileron controls used to make turns in flight.

The X-114 is now being tested by the West German Navy in the Baltic Sea, near Kiel. Military interest, beyond straight research, is for possible use of the X-114 as a search-and-rescue craft. The current research program is aimed at flying across the Baltic Sea, where 80 percent of the waves are five feet high, Fischer told me.

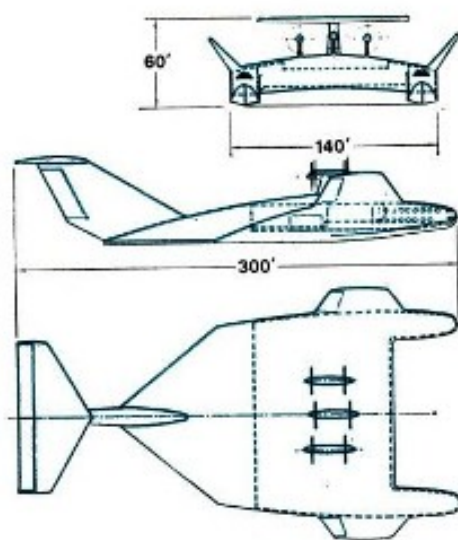
I also learned from Washington sources, who preferred not to be quoted, that although the U.S. Navy is presently pursuing no major active program, it is "keeping



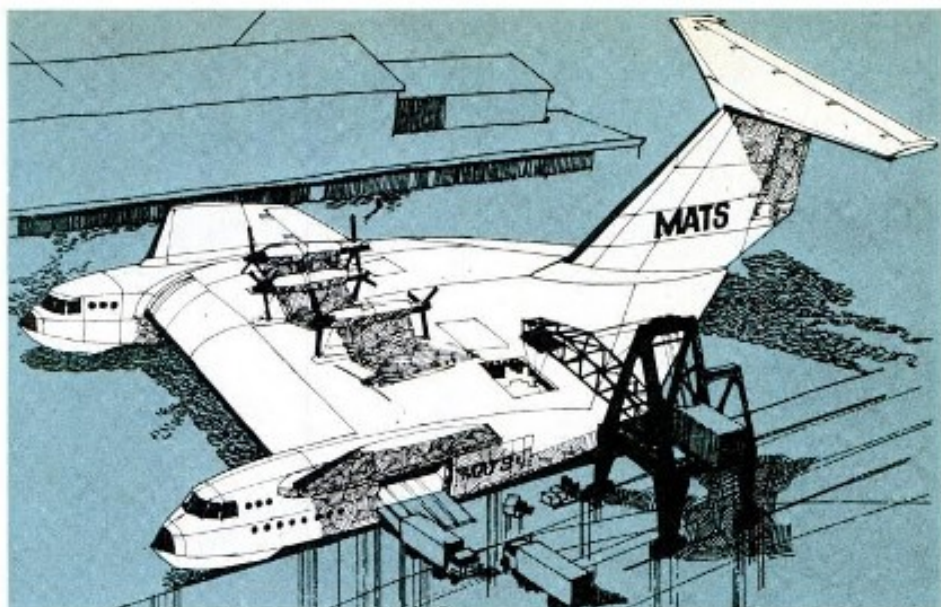
Navy cargo vehicle would rotate the back of its turbofan engines down 30 degrees during takeoff. As it developed for-

ward motion, Lockheed-Georgia's 700-ton design-concept craft would be blown off the water much like a Hovercraft.

craft's control wheel"



Ocean-going surface-effect ship conceived by the Lippisch Research Corp.



would weigh 300 tons. Vehicle could carry freight and passengers at low cost

and at speeds several times higher than those of conventional shipping.

current" on the West German research as well as monitoring Soviet progress on very large multi-engine versions of the aerofoil boat.

Russia's Ekranoplan

Photos have appeared of early Soviet designs that look like exact copies of early Lippisch models. The Russians are also reportedly flying a large 10-engine, 500-ton experimental "Ekranoplan." One authoritative source estimates that one version of the craft, designed for antisubmarine warfare, could fly 350 mph at 25 to 50 feet over the water.

A sketch of the Russian craft shows eight jet engines that are mounted on a stubby canard forward wing and aimed so that their jet blast hits the water and bounces back up under a big rear main wing. This creates a high-pressure area and provides lift similar to a Hovercraft's.

Another intriguing design is by Lockheed-Georgia. It's a study for the Navy of a big four-engine turbofan-powered craft. Lockheed has been considering a machine that will weigh 1.4 million pounds, carry a 441,000-pound payload, and cruise 3.8 feet over the water surface at Mach 0.4 (about 300 mph).

The Lockheed proposal, pictured on these pages, is for a huge logistics vehicle to transport large amounts of cargo long distances at speeds much higher than those of conventional surface transportation. This design is for a craft 238 feet long with a wingspan of 108 feet. I was told that no models or smaller versions have yet been made.

The future?

Dr. Lippisch proposed three possible future types of aerofoil boats:

- Small vehicles for sport, recreation, and inland transport missions on rivers and lakes. These would be

one-half to three tons in weight and cruise 60 to 100 mph.

- Medium-size aerofoil boats that would weigh up to 50 tons and cruise at 200 mph.

- Large ocean-going versions of the ram-wing type that could be 1000 tons or more. He predicted that these would not be able to fly high out of ground effect, but could rise to at least half their wingspan. This would enable them to fly over high waves and small obstacles. Their cruising speeds would be about 350 mph.

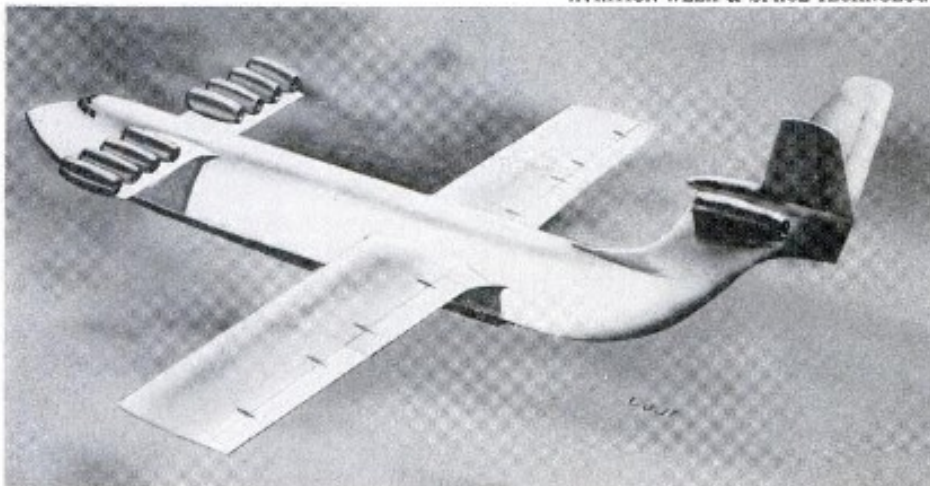
Military uses of these craft could include fast patrol boats, antisubmarine craft, troop carriers, or landing craft.

How about civilian uses?

Originally, the ground-effect plane was proposed for relatively undeveloped areas. In the few short years since Dr. Lippisch got his project off the water, however, we have run head-on into the energy and fuel crisis.

Stretching fuel

The supersonic Concorde is running into serious opposition because it uses a lot of fuel per passenger—even though it saves considerable chunks of time. Airline companies and aircraft manufacturers are worried about the rising prices of fossil fuels and are hoping for fuel-saving designs and engines. It is no secret that the aerofoil concept has been on the back burner for several years. With the obvious need to stretch the world's limited fuel reserves, however, this concept of going farther on less fuel by flying closer to the ground may soon get more urgent consideration by aircraft designers.



Russian craft gets lift from air bubble caused by jet blast bouncing off water beneath its main wings. Eight-engine

aircraft was reportedly tested in 1974; newest versions, suitable for antisubmarine warfare, may go 350 mph.

AVIATION WEEK & SPACE TECHNOLOGY

POPULAR SCIENCE

AUGUST • 35c *Monthly*



First **Really** Portable TV

- ▶ How It Works
- ▶ How Good Is It?

PAGE 64

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First Really

*Here is battery-powered television
in a small, transistor receiver
to take—and use—wherever you go*

By Martin Mann

HOW IT WORKS:

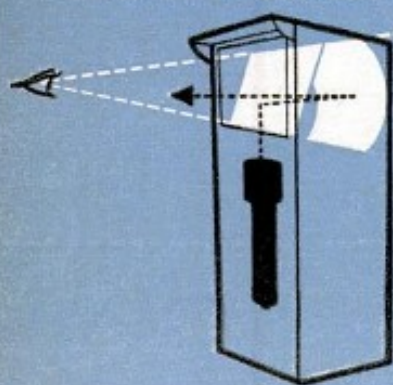


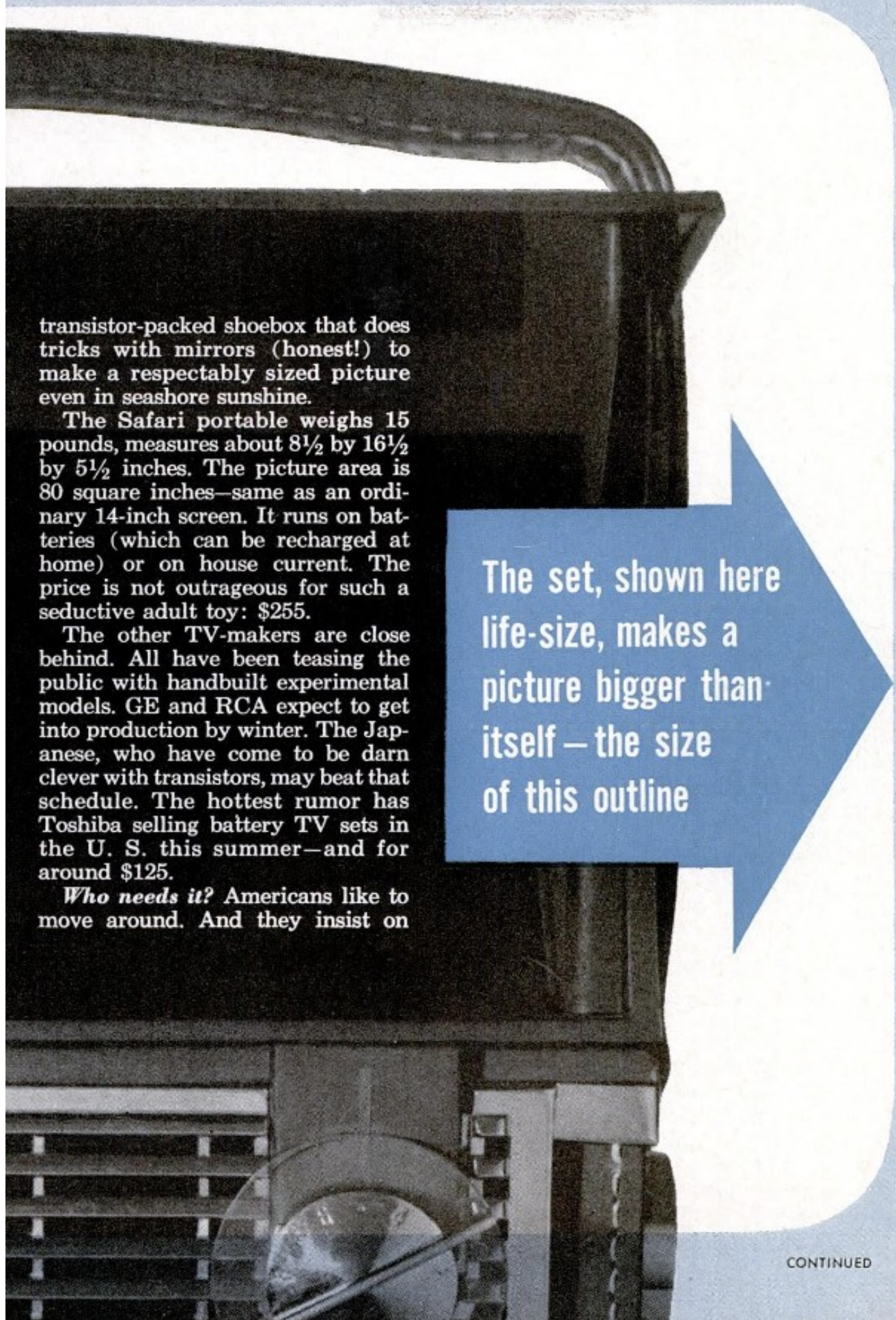
Image behind set—four feet away—is created by concave magnifying mirror. Front mirror—half-silvered—reflects picture tube to it, also lets you look through.

NOW they've gone and done it. They've built a TV set you can take with you: a genuine portable—battery-powered. You no longer need a power cord, or an outlet, to plug it into.

It works just about anywhere except under water. You can go to the beach without missing the ball game, enjoy Lawrence Welk from a canoe, catch Jack Paar while camping out or, more practically, keep a child quiet in the back seat on an auto trip.

Philco is first, by virtue of remarkably imaginative engineering. Its production lines are now stamping out the Safari, a leather-covered,

Portable TV



transistor-packed shoebox that does tricks with mirrors (honest!) to make a respectably sized picture even in seashore sunshine.

The Safari portable weighs 15 pounds, measures about 8½ by 16½ by 5½ inches. The picture area is 80 square inches—same as an ordinary 14-inch screen. It runs on batteries (which can be recharged at home) or on house current. The price is not outrageous for such a seductive adult toy: \$255.

The other TV-makers are close behind. All have been teasing the public with handbuilt experimental models. GE and RCA expect to get into production by winter. The Japanese, who have come to be darn clever with transistors, may beat that schedule. The hottest rumor has Toshiba selling battery TV sets in the U. S. this summer—and for around \$125.

Who needs it? Americans like to move around. And they insist on

The set, shown here life-size, makes a picture bigger than itself — the size of this outline

Mirrors turn the trick: From small tube, cheap battery, they make a big picture you can watch in bright sun

taking their entertainment with them—the magazine rolled into a pocket, the portable radio held at ear level.

Carry-along TV is a natural addition. Even at home, it's a convenience: You can take it out into the back yard, or simply move it from room to room without crawling around stabbing at an outlet.

But the manufacturer's motive for gambling a million or so on such a new product can be considerably more complex. He may hope that (a) people will buy the gadget because it is a Practical and Useful Convenience; or (b) people may not need the gadget but will buy anyway because it is The Thing to Do, like dancing the cha-cha-cha; or (c) people will come into the store to see the Amazing New Invention and end up buying something else he wants to sell, as they look at convertibles and buy sedans.

What's so difficult? All the big electronics labs have had orders from above: Make us a salable transistor TV set. The resident geniuses failed to deliver, until now, for three very good reasons:

1. Picture tubes were too bulky, too heavy, and too hungry for electricity.

2. Batteries were too bulky, too heavy and too weak—unless very costly.

3. Transistors for the very high frequencies of television circuits were too expensive, mainly because they couldn't be manufactured uniformly.

Problem number three is in hand. Philco has geared up an automatic assembly system that cranks out transistors more than a third cheaper than before. Even so, a Safari contains 60-odd dollars' worth of transistors.

Recent developments in rechargeable batteries ("Clever New Gadgets Run on Flashlight Batteries," PS, March) ease the power bind somewhat, although hardly enough to suit the TV designers. They don't make batteries, and can afford to be unreasonable. The Philco set contains a package of five cells (labeled Philco but made by Eveready). It goes four hours between charges, can be recharged maybe 20 times, and costs around five bucks to replace when it's finally shot—about six cents an hour for power.

This is a pretty small battery. The

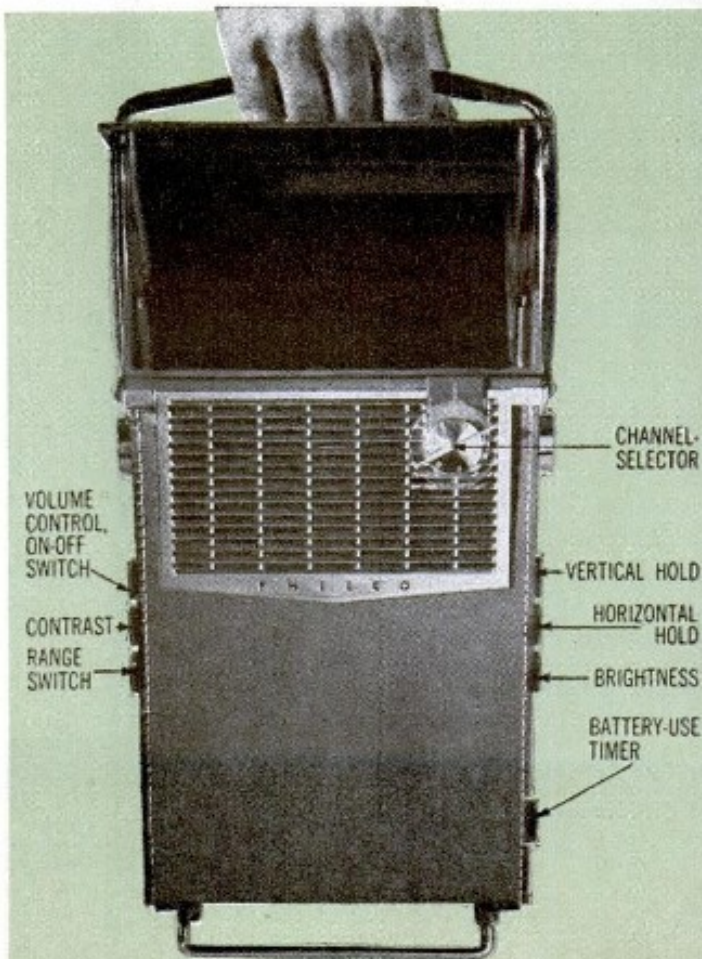
portable TV set draws only $4\frac{1}{2}$ watts—a living-room receiver draws 200. Philco gets away with it partly by prudent design (project engineer Al Curll remarks, "We wouldn't dream of adding a pilot light"), but mainly it's because of a unique solution to the picture-tube problem.

The ideal solution would be a solid picture tube, built like a transistor to operate on a trickle of power. So far this is still a gleam in the eyes of the long-hairs who practice quantum mechanics.

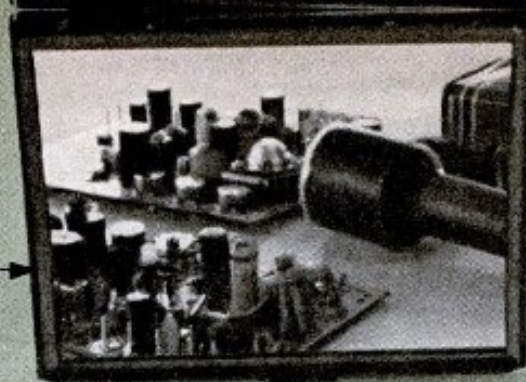
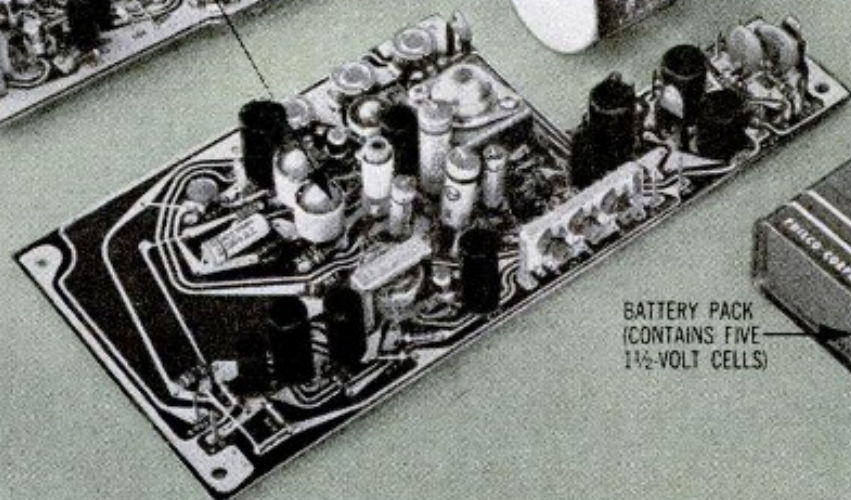
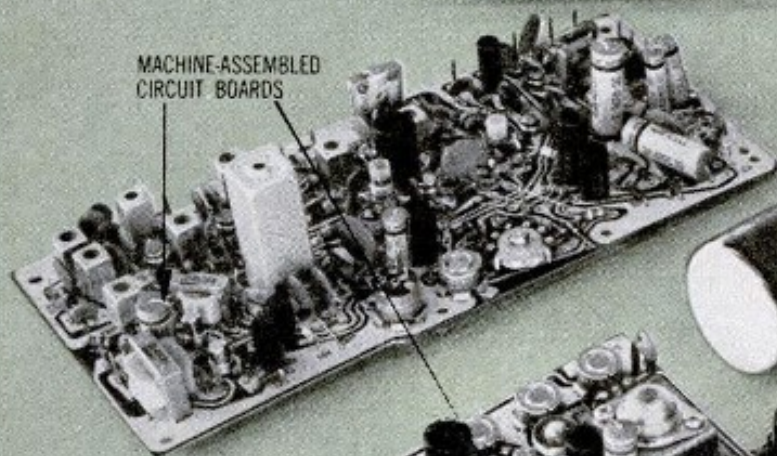
Philco finessed. The bright idea came to research v-p Dave Smith when he was flipping through that standard source of inspiration, the Sears, Roebuck catalogue. He saw Sears' slide viewer.

The slide viewer is a \$10 optical gadget that shows you an enlarged image of a 35-mm. photo transparency when you hold it up to your eyes. The picture

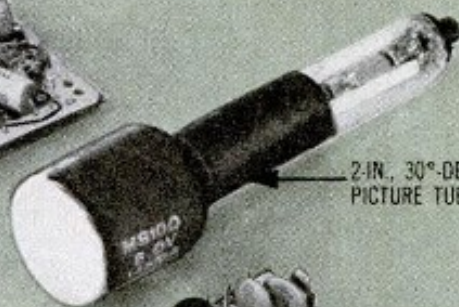
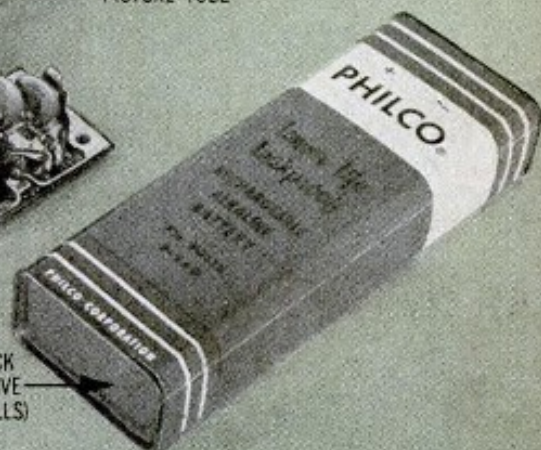
COMPACT AND LIGHTWEIGHT, Philco's Safari is a bit larger than a shoebox, weighs 15 pounds. Most of bulk is accounted for by mirrors, picture tube and battery pack (opposite page). Transistor-studded boards form sides of chassis. Visor (shown up) shades viewing system, protects it when closed. Brass stand adjusts to tilt receiver for comfortable viewing angle.



MIRROR UNIT

MACHINE-ASSEMBLED
CIRCUIT BOARDS

SPEAKER

2-IN., 30°-DEFLECTION
PICTURE TUBEBATTERY PACK
(CONTAINS FIVE
1½-VOLT CELLS)

seems to float in space some distance behind the viewer. It is a "virtual" image, like the image of yourself you see when you look in an ordinary mirror—your reflection appears to be a person standing behind the mirror.

The same kind of optical system sits atop the Philco portable. It has a concave mirror to magnify the face of the picture tube. To see this magnified picture, your eyes focus on a point *four feet behind* the TV set. So the image you watch is large, and appears to be hanging in space behind the set.

And that's the secret. It means:

- You can use a very small picture tube—two-inch screen—with great savings in cost, bulk and weight.

- A small tube gets by on less electricity, so you save on batteries. The reason is that much of the power goes to swing the electron beam back and forth. A small tube can be built with a narrow

swing (30 degrees instead of 110) without becoming impossibly long.

- Bright sunlight can't wash out the picture because you don't look at the tube face directly. The image you focus on is four feet behind the case, so you can stick your head right up under the little visor and watch in comfort.

Naturally, you don't get all this for nothing. The small tube has to be carefully made, precisely positioned and protected against dust. Otherwise, any defect will be magnified along with the picture.

More important, to see the picture at all you have to sit close to the set and squarely in front of it. If you move off the center line, the image slews out of sight. And this means just one person can watch. Two people can see only if they are on very, very friendly terms.

How good is it? Philco's engineers were ordered to produce a genuine portable. It

[Continued on page 192]

POPULAR SCIENCE

JUNE • 35¢ Monthly

Navy's New Undersea
**Hit-and-Run
Raider**



Preview of **U.S. Rear-Engine Small Cars** **PAGE 51**

7 New Ideas for Vacationing on Wheels **PAGE 138**

MECHANICS and HANDICRAFT SECTION **PAGE 125**

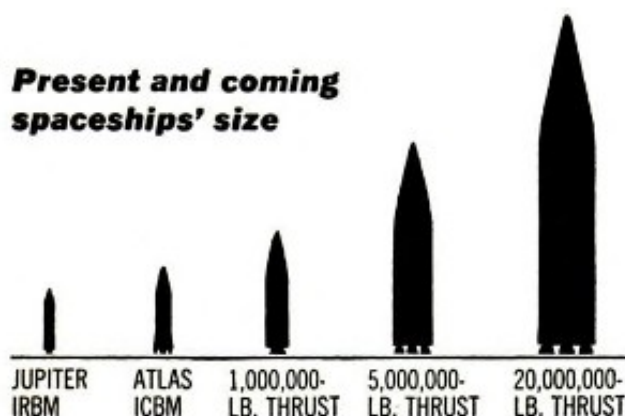
Материал, защищенный авторским правом

Mighty spaceships to come will follow the trail to the moon and planets blazed by Pioneer IV, our first vehicle to escape from the earth

U.S. Super-Rockets On the Way

AN ATLAS ICBM will be merely the second stage of U. S. super-rockets coming up. Their first stage will be an engine of more than million-pound thrust. One of two versions under development, the Army's, will combine eight Atlas-style engines of 150,000 pounds' thrust apiece. A giant single-nozzle Rocketdyne version will follow.

Present and coming spaceships' size



In further steps foreseen by T. F. Dixon, Rocketdyne's chief engineer, a cluster of these engines will yield a 5,000,000-pound-thrust booster; next will come a single 5,000,000-pound-thrust engine; then, a cluster of these, with the fantastic thrust of 20,000,000 pounds.

Built at their launching sites like great liners, the resulting spaceships will implement bold U. S. plans: to put radios and telescopes on the moon, to send men there within a decade, to probe near and distant planets. On ever-increasing scale the ventures will progress beyond our first success in sending a vehicle beyond reach of the earth's gravity—our Pioneer IV space probe, pictured opposite. What's coming next is shown on the reverse side.

Our First Man-Made Planet in Actual Size

NEWLY ornamenting the solar system is a piece of man-made jewelry, our Pioneer IV space probe. The golden cone, with black stripes, has become the first U. S.-launched object to escape the earth's gravity, and belie the adage that what goes up must come down.

Borne into space by a four-stage rocket vehicle from Cape Canaveral in Florida last March, Pioneer IV now circles the sun as the planets do, in an orbit weaving back and forth across that of Earth. For eons to come, it will be an artificial planetoid—like the Russians' Mechta, a two-foot-diameter globe of stainless-steel segments alternately painted black and white, which attained a similar orbit last January.

While Pioneer IV was outward bound, its radio transmitted the best measurements ever made of the newfound and perilous radiation belts beyond the earth—and was heard as far as 410,000 miles away, a new distance record for messages from space. The cone's striped pattern, by absorbing just enough heat from the sun's rays and reflecting the rest away, kept instruments and radio at the right temperature during the transmitter's brief but fruitful life.



TRUE-COLOR

Pictures

BLITZ-BOY

RADIATION
DECK

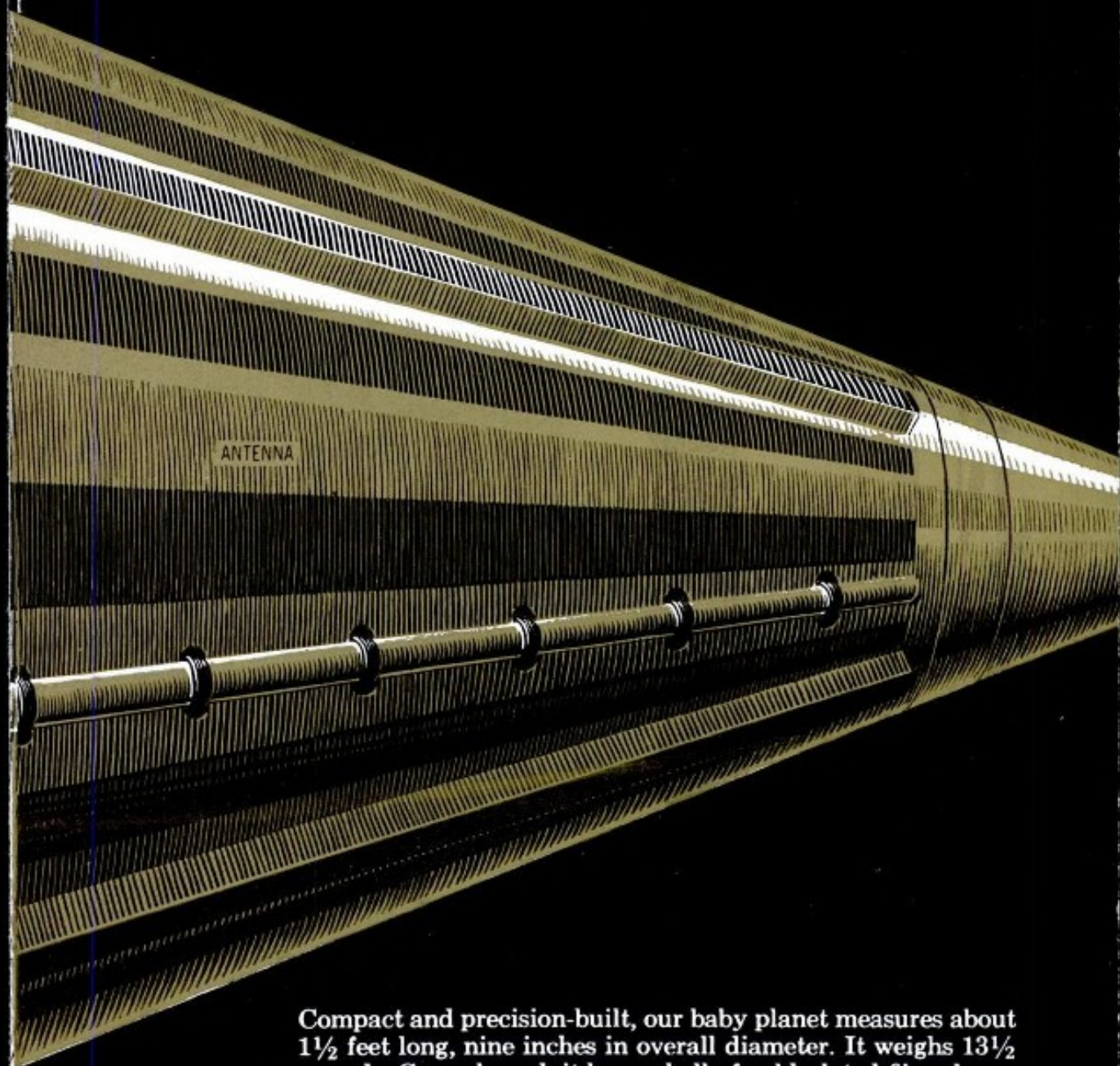
RAY PROCT

PORTRAIT of artificial planetoid

shows its design inside and out.

at right tell how it reached

needed speed to leave earth forever

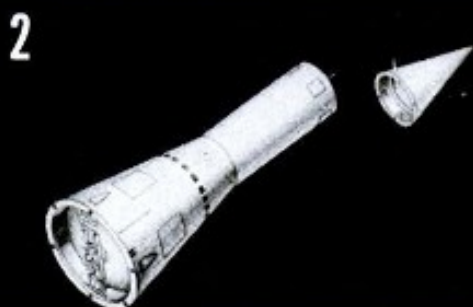


Compact and precision-built, our baby planet measures about 1½ feet long, nine inches in overall diameter. It weighs 13½ pounds. Cone-shaped, it has a shell of gold-plated fiberglass—which, during the batteries' life, served as its radio antenna. Inside are instruments for measuring high-intensity radiation in space; and a tiny but far-ranging transmitter, which reported the readings to earth. Protruding at rear is the "eye" of an optical trigger—which went untested because Pioneer IV passed wide of the moon—such as may trip future spaceborne cameras for photographs of the lunar surface.

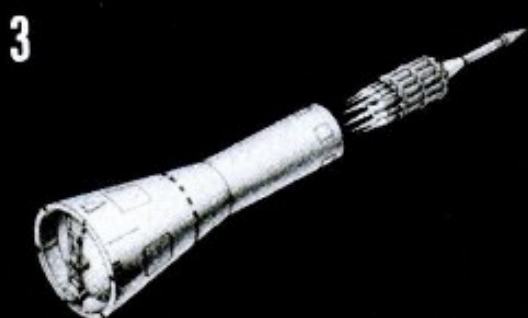
Pioneer IV's four-stage Juno II launching vehicle rose vertically, arced to inclined course. First stage, shown dropping away at burn-out, was Army's big Jupiter IRBM, modified to carry extra fuel.



Upper-stage assembly, in rotating "tub," coasted on and shed its protective nose shroud. Small rockets kicked the discarded shroud sideward, out of way.



Second stage, a cluster of 11 solid-fuel Sergeant rockets, then ignited and accelerated the payload skyward. The spinning tub, having served its purpose, fell away.



Third stage, of three more Sergeant rockets, gave the speeding payload its next upward boost. The spent second stage was left behind, to fall back toward earth.



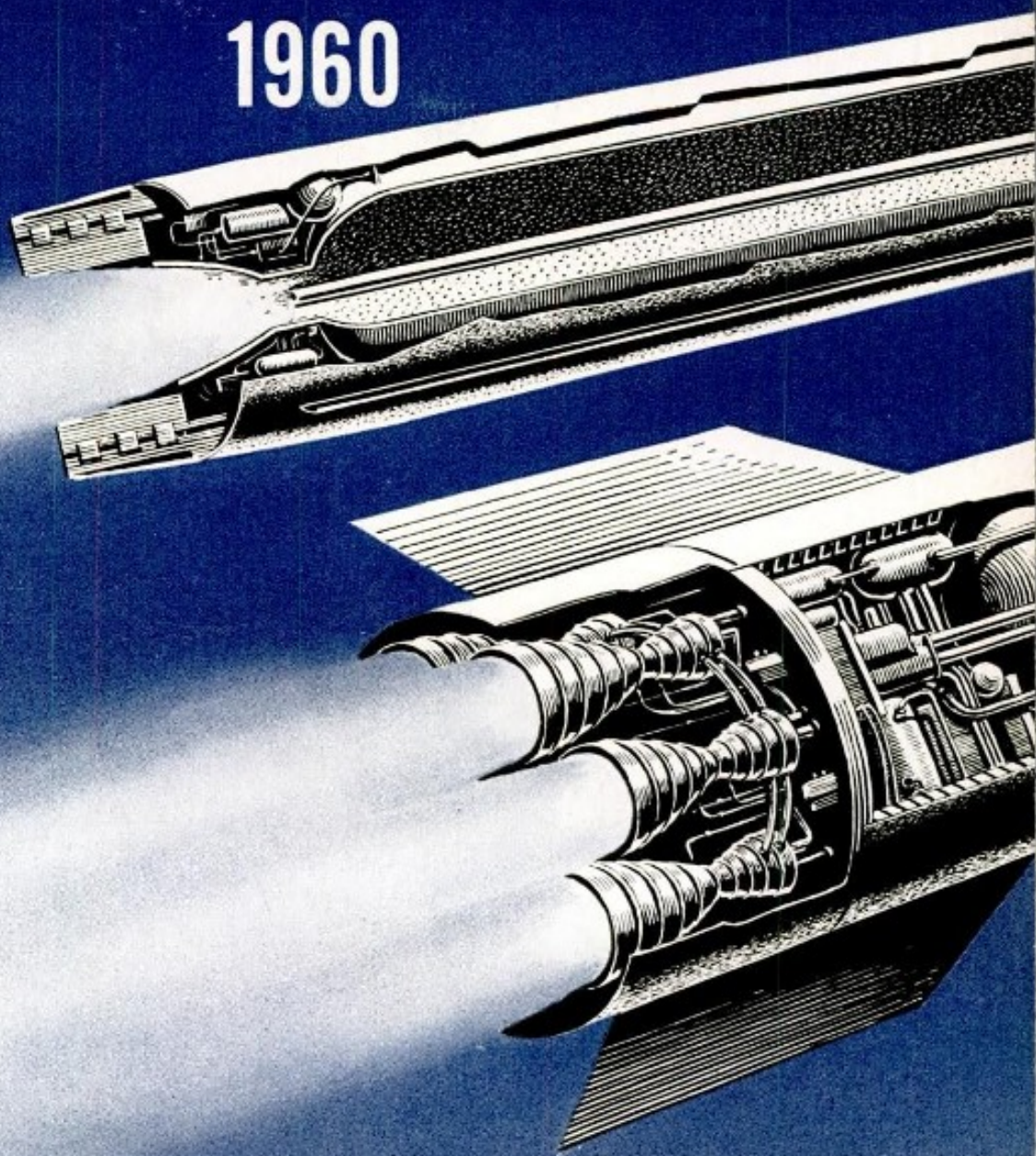
Fourth and final stage, a single solid-fuel rocket with Pioneer IV probe at its nose, made the successful dash that reached "escape velocity" of nearly 25,000 miles an hour.



Pioneer IV probe discarded spent rocket (note clamp flying apart) to uncover "eye" that was to sight moon. But probe passed too wide of moon for the test, on its way to solar orbit.

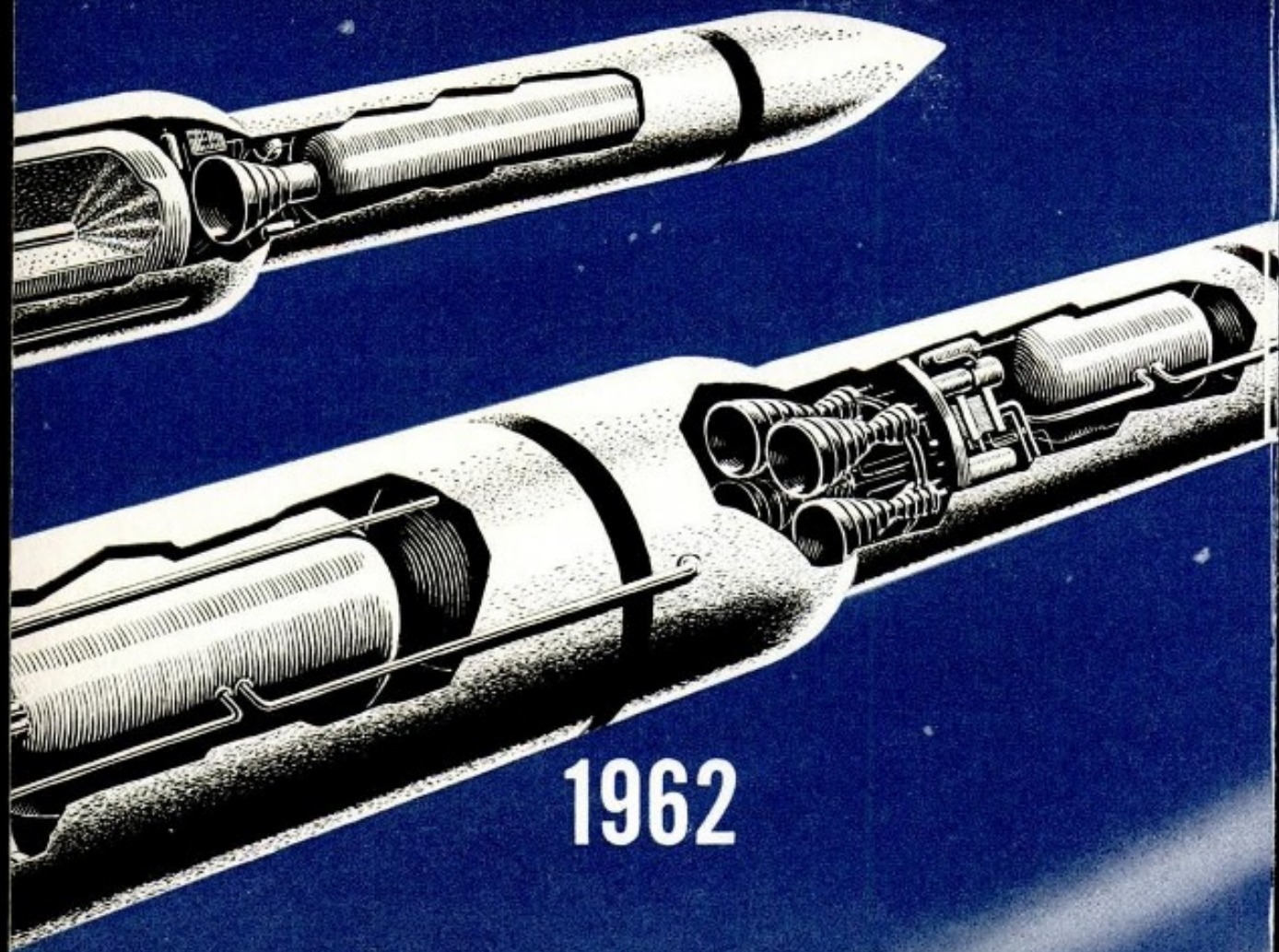


1960



The Coming Fleet of U.

WHAT'S ahead in our space plans—and when—is pictured in these drawings, based on Rocketdyne engineers' generalized conceptions. Big solid-fueled rockets like the 35,000-pound "Scout," due by mid-1960, will multiply our pioneering astronautical ventures by moderating their present high cost. Outstanding longer-range development will be of enormous spaceships with rocket engines of unprecedented power. By 1962, a current project should yield a "clustered" rocket engine of 1,500,000 pounds' thrust, for the booster or first stage of the Army's monster "Saturn" rocket, which will be capable of such mis-



1962

S. Spaceships

sions as stockpiling cargo on the moon for future lunar colonists. Next step, a single-chamber rocket engine of equal power, is expected by 1970 to lead to a multi-nozzle, 6,000,000-pound-thrust "clustered" booster (lower view), as for a great NASA "Vega" rocket. Also by 1970 (upper view), experimenters hope to perfect a low-thrust but long-lived ion-propulsion engine to propel a spaceship's upper stage on far voyages in the solar system. Nuclear rockets, powered by uranium-fueled atomic reactors, and applicable as boosters, upper stages, or both, should be ready by 1975 to carry the greatest space payloads of all.



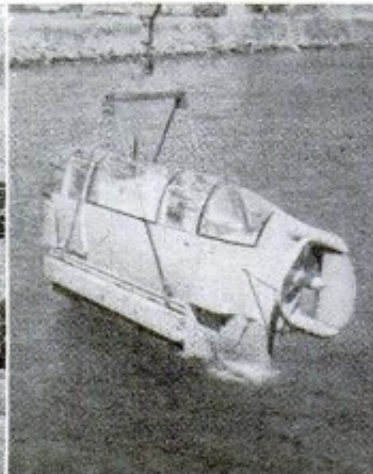
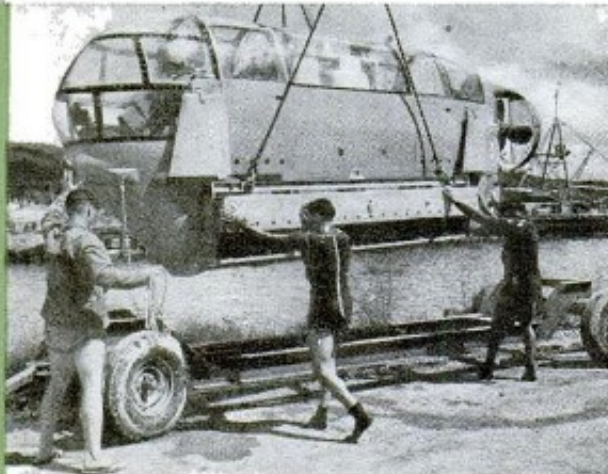


1975



Navy's New Undersea Hit-and-Run Raider

NAVY'S TWO-MAN SUB arrives dockside at St. Thomas, Virgin Islands, above, and launching crane hooks on; frogmen, right, help guide the miniature submarine from dolly for swing into the water; far right, the minisub is ready for boarding by its two-man crew and a trial run in the Caribbean's depths.



Handling the Aquabat is like flying a plane. But this two-man sub lands at the sea bottom for its deadly work

By Frank Harvey

TIME was when you could anchor your aircraft carrier inside some landlocked harbor, string anti-sub nets, plant a flock of mines and take off for the officers' club without a care in the world. When the liberty boat brought you back in the morning, the old flat top would still be there, safe and sound.

Those cozy times are now gone forever—at least for naval enemies of the U.S. The Navy's newest gadget, a deadly little two-man submarine known as the Aquabat, can sneak past sub nets and mines, and—with an atomic kill charge, if necessary—blow a mighty carrier out of the water like a bug.

The Aquabat handles very much like a light plane. I sat in one at Navy winter training quarters for frogmen, St. Thomas, Virgin Islands, and was given a complete "flying" lesson by Frank Moncrief, Underwater Demolition Specialist, who

was piloting the tiny giant-killer on her shakedown cruise.

"We've toyed with minisubs before, as you probably know," Moncrief said. "But they were Model T variety. You had to foot-pedal them, and by the time you got where you were going, you were as pooped as if you'd swum there in open water."

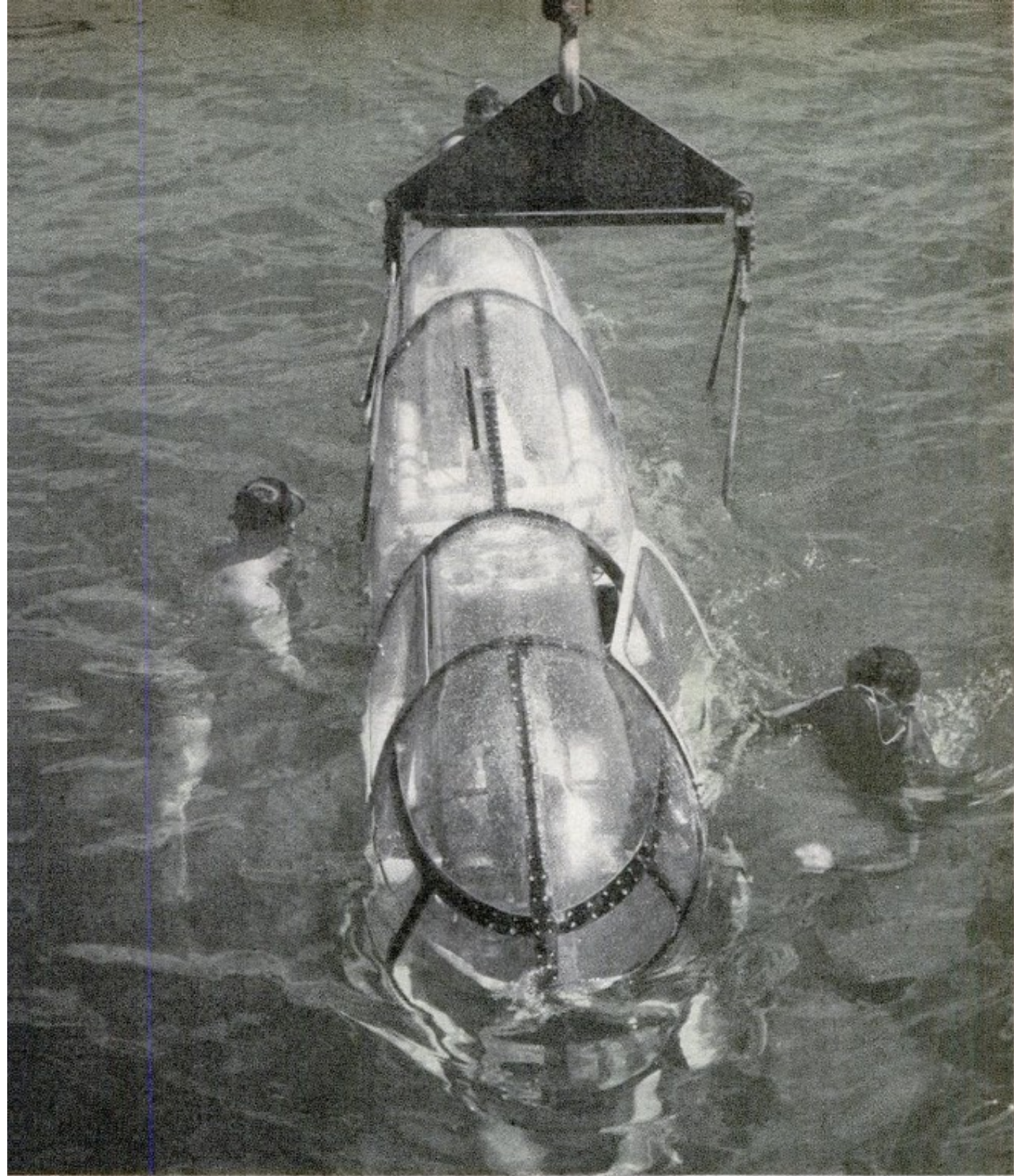
Moncrief tapped the control stick of the Aquabat lovingly.

"This baby," he said, "is a Cadillac. Four doors, full dual controls, high-powered batteries, every instrument you could wish, plenty of speed and range."

"How about weapons?"

"Yeah," Moncrief said, "she's got weapons that would turn any surface skipper's hair white as cotton. Don't ask me the details."

Moncrief then climbed into the rear seat of the Aquabat, which was on its dolly in the hangar, and I climbed into the front seat. We slipped into frogmen's masks and held our check-out confab



FROGMEN guide the Aqua-bat out of the launching cradle (above). Man on right opens the door of front pilot's seat from which he will steer. At right, the sub begins its dive. Pilot, at controls, is already underwater. Copilot, in rear, turns to give last look at daylight before he too goes under.





With an Aquabat, frogmen can sneak past nets and mines,

Any sort of ship, an innocent-looking rowboat or a submerged mother submarine can launch the Aquabat.



To dive, the pilot floods ballast tanks—just enough to make the ride steady.

Parked on the ocean floor, the two crewmen adjust portable air tanks on their backs.



over an intercom, just as if we were in an airplane. Moncrief's voice was wonderfully clear. He said it comes through just as well underwater.

The Aquabat, developed during the past three years by the Special Devices Group of the Navy's Underwater Sound Laboratory, at New London, Conn., is substantially bigger than any of its pred-

ecessors. It's 20 feet long, 6½ feet high and three feet wide.

It can be dropped miles from its target by any sort of surface ship, Moncrief told me. Even an innocent-looking rowboat with an outboard motor can tow it. Or it can swim off the back of a submerged mother sub.

Made largely of aluminum, it does not attract magnetic mines. Its full Plexiglas canopy gives both crew members an all-around view of the watery landscape. This helps them to avoid hitting coral heads and makes it easier to see an underwater target.

For most of every journey submerged, the Aquabat finds its way by compass and depth gauge. These are located in both the forward and after cockpits.

Each cockpit has two control sticks, mounted side by side about six inches apart. The left one moves the bow planes, the right one the stern planes. For fancy maneuvering (or faster diving) they are operated individually. But for normal cruising they are lashed together with a top clip. Duplicate sets of controls enable either crewman to take over.

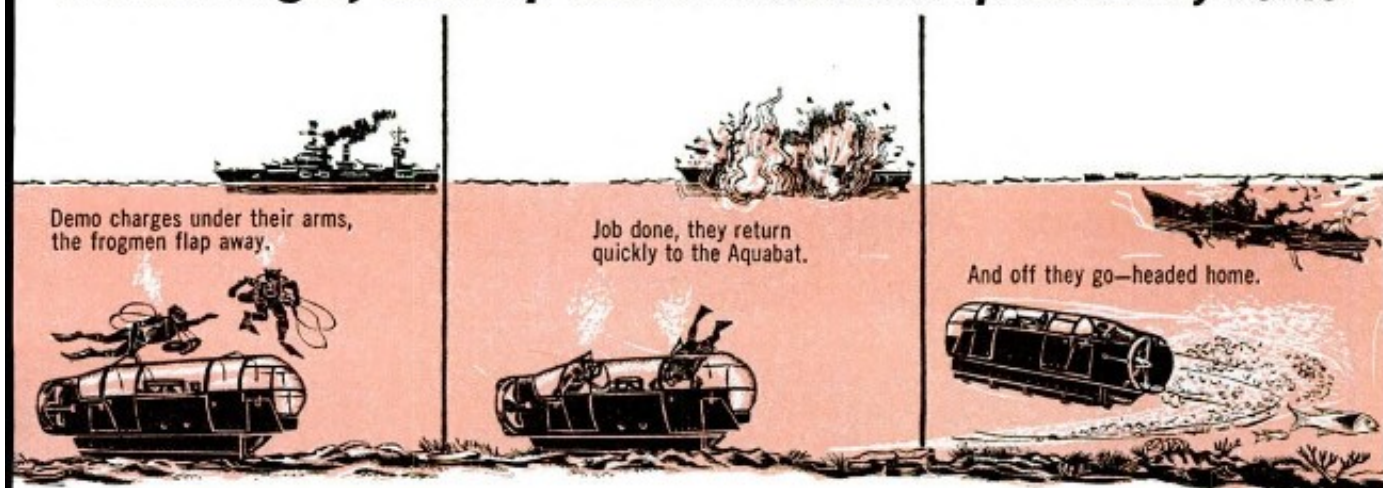
As the Aquabat submerges, water automatically fills it, flooding in through holes at the bottoms of the doors. So the crewmen must always be in diving masks. For the trip from mother ship to target area and back, they breathe air from the sub's own tanks. When they are ready to leave their little ship to do a demolition job, they plug in to the air tanks on their backs. Making the switch underwater entails hair-raising risks.

To dive the Aquabat, I learned, the man at the controls first floods ballast tanks to give it neutral buoyancy—just



TEST PILOT of the Aquabat is Frank Moncrief, Navy frogman, shown in front cockpit with diving mask and intercom. Left control stick works the bow planes; right one, the stern planes.

send a mighty warship to the bottom and speed safely home



enough to make it ride steady at the depth he wants. Then he simply pushes the stick forward, as in a light plane. The diving planes tilt and the sub noses down. To level her, he pulls back on the stick and trims for neutral buoyancy at the new depth. (The ship must now be heavier, of course, to stay down.)

If the Aquabat should ram a mudbank (and the crewmen wear safety belts to hold them in place in case of such an emergency), its pilot can get the little vessel unstuck by forcing water out of the ballast tanks with compressed air, with propeller reversed.

Parking on the bottom. When the sub has traveled, at a smart five or six knots an hour, to the spot it's headed for, the pilot floods a big tank in its belly, and the ship sinks to the bottom. There it lies, like a heavy stone, while the crewmen flap off with their demo charges under their arms.

If an accident should jam the doors shut, either crewman can easily escape from his cockpit by standing up and shoving his head and shoulders against the canopy. This forces pop-out panels to give way and clear an escape opening.

When the crewmen are ready to head for home, one of them blows out the ballast tanks to give the ship positive buoyancy, then pulls back on the stick, and off and up they go.

"How long does it take to learn to fly this bird underwater?" I asked Moncrief. "I heard the foot-pedal job was so simple anybody could master it in half an hour."

"This one isn't that simple. It takes a lot longer than half an hour to get the hang of it. But she does so much more that the extra trouble is worth it."

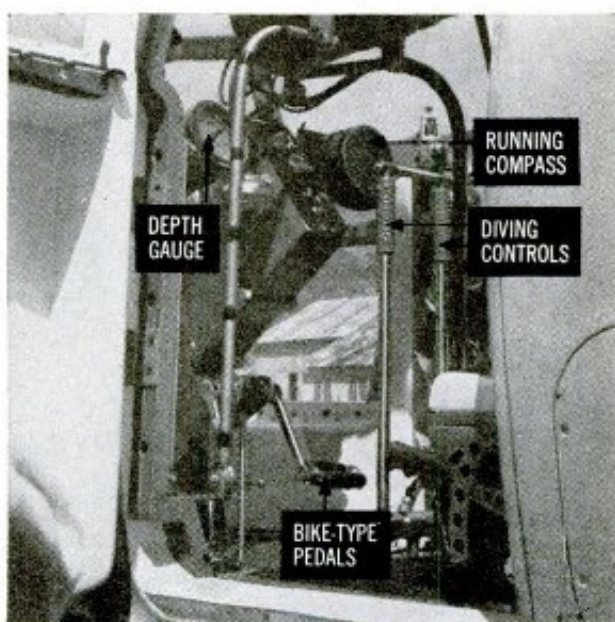
"Can you fire torpedoes?"

"Sorry—no details on armament."

"Those homing torpedoes don't need a tube for firing," I said. "You just drop them in the water near a target and they take off and kill it—right?"

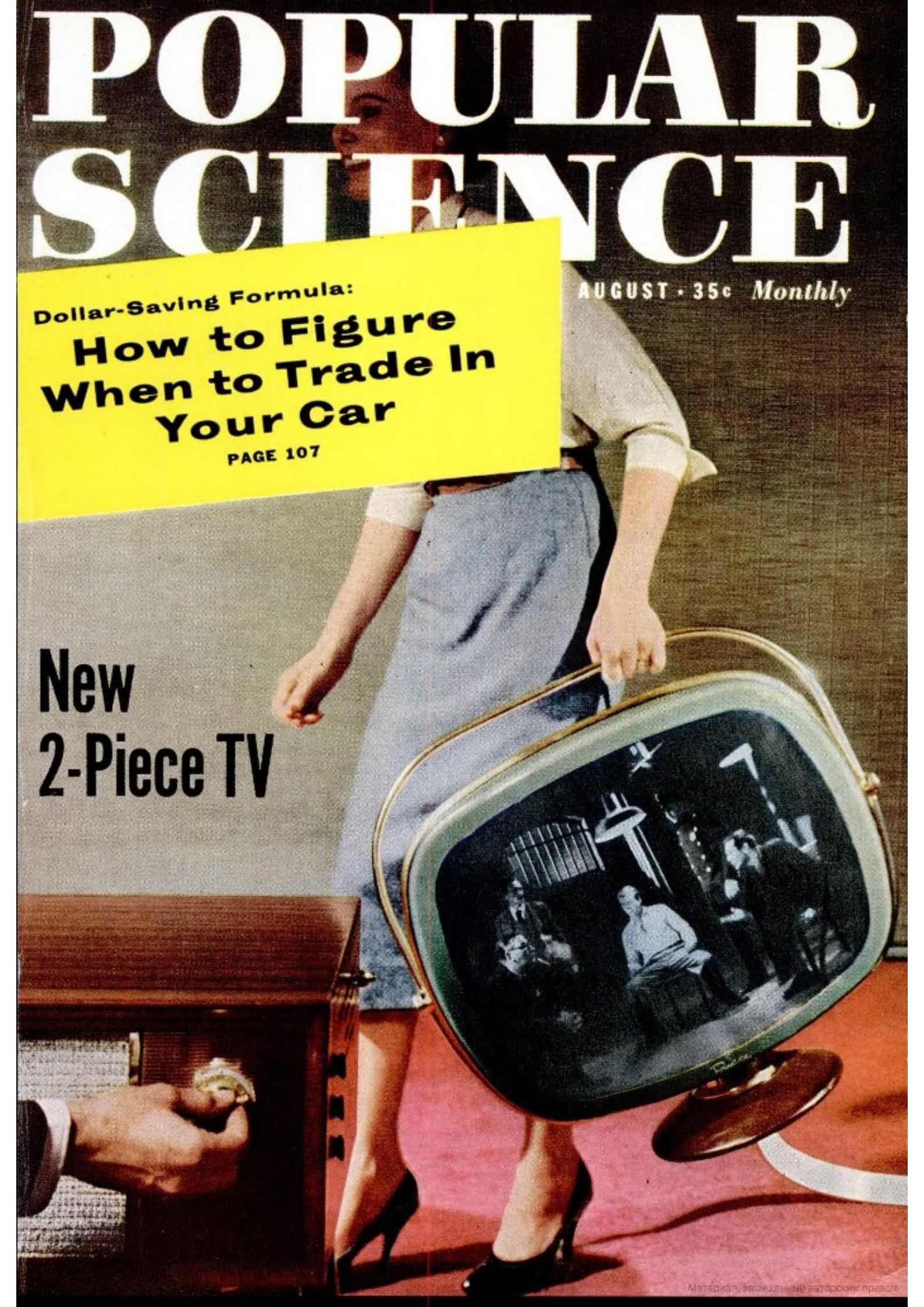
"Are you asking me or telling me?"

I didn't press—but if Frank Moncrief reads this, I'll lay him a little bet of 10 bucks to a dollar that the Aquabat *will* carry homing torpedoes as soon as she joins the fleet in quantity, which she will shortly do. And when that happens, the sky is the limit. A torpedo with a hydrogen warhead, for example, would blow up more than a ship. It would blow up a good-sized seaport. And there isn't any reason in the world why such a weapon couldn't be loosed from a simple clip on the flank of an Aquabat.



FRONT COCKPIT of Aquabat, with pilot out, shows marked resemblance to lightplane's. **END**

POPULAR SCIENCE

A woman in a light-colored top and blue skirt is walking and carrying a large, rounded television set. The television screen shows a black and white scene of a man sitting in a chair, with other people and a large structure in the background. The woman is also carrying a small, round object in her right hand.

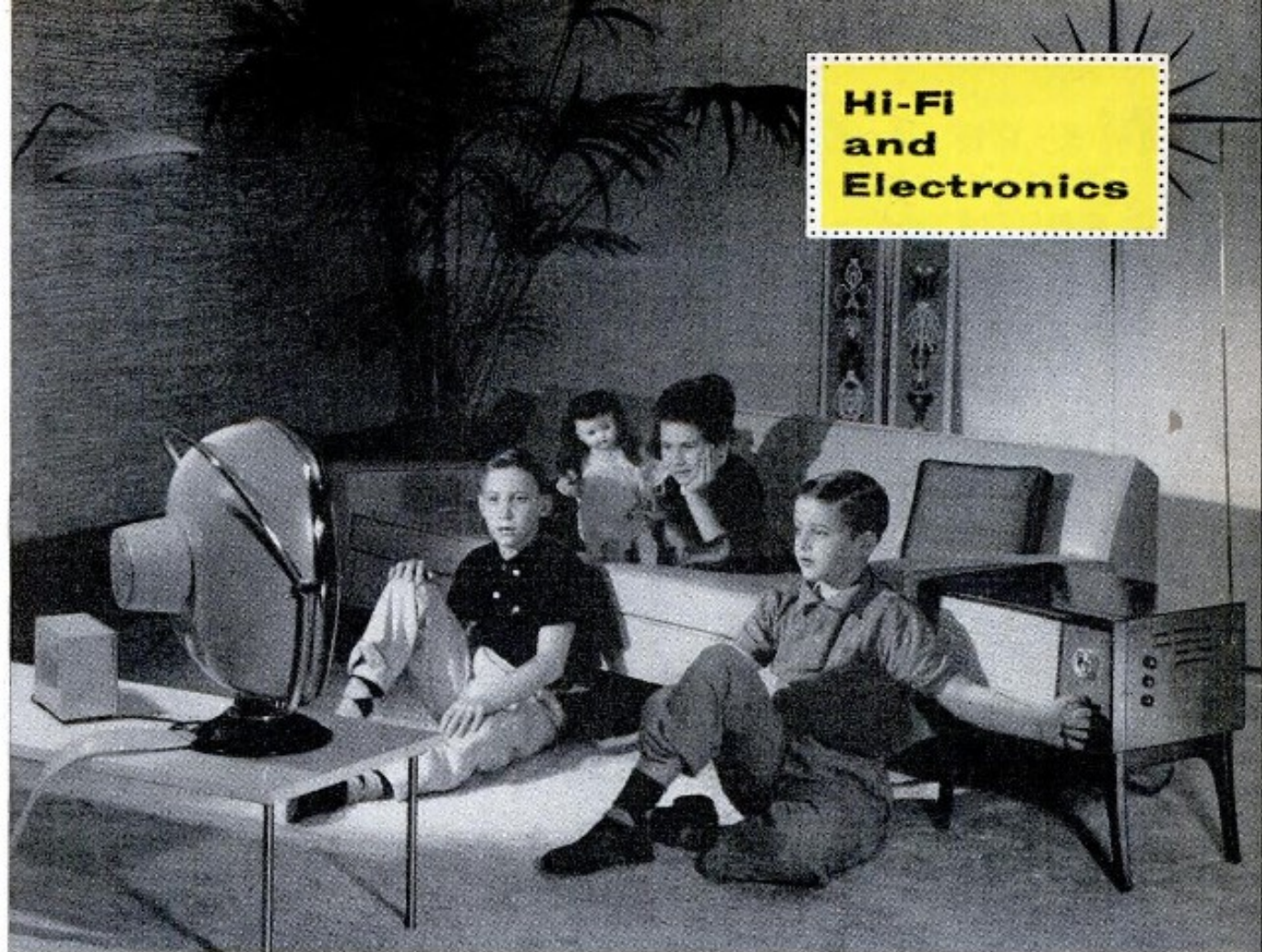
Dollar-Saving Formula:

**How to Figure
When to Trade In
Your Car**

PAGE 107

AUGUST • 35c Monthly

**New
2-Piece TV**



2-Piece TV Has Portable Picture Tube

Designers pluck the tube out of the cabinet and stand it by itself in Philco's '58 line

By Hubert Lockett

A MANUFACTURER of television sets has about as much chance of keeping a radical development secret as he would an elopement planned on a rural party line. The picture tube pretty much dictates the basic dimensions of any styling change. And all picture-tube envelopes come from the same supplier.

This was the problem facing the planners at Philco two years ago. They had been poring over statistics that pointed to a distinctly unhappy future for TV manufacturers.

The discouraging prospects appeared to be these:

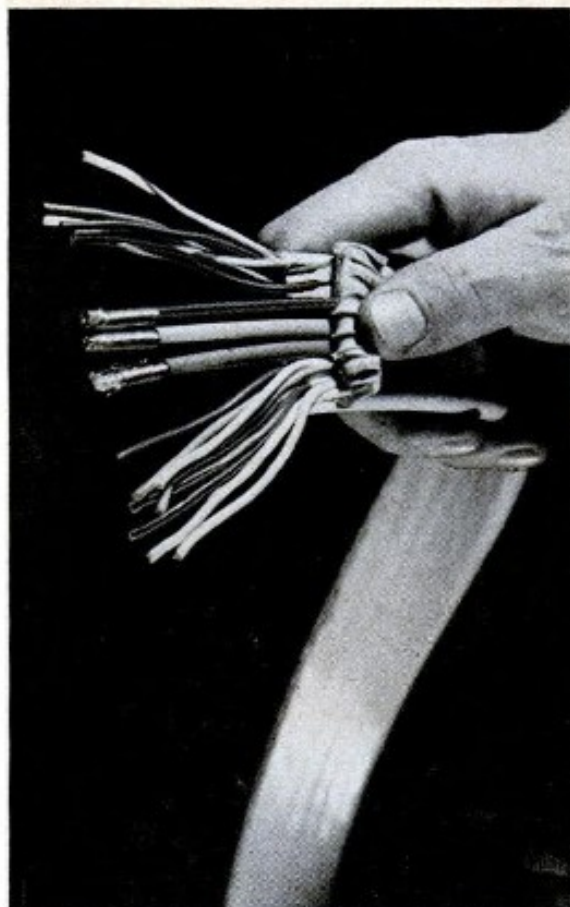
- Just about everyone not still reading

by a kerosene lamp would own a TV set by 1958.

● People were hanging on to their old sets. Customers who would sooner let their wives wear last year's fashions than drive a five-year-old car were still watching TV sets that had been bought six or seven years before.

Taking a disenchanted look at the sets introduced annually since the 21-inch tube became standard, Philco's market analysts made a surprising discovery: It was almost impossible to distinguish the latest models from those of three or four years back. Except for the larger tube face, the basic idea of a TV set had never changed—it was simply a box with a window in it.

The industry had failed to develop a re-



PICTURE PIPELINE: A fistful of conductors are molded in a flat ribbon of tough plastic to supply operating voltages and signal to the remote picture tube. Cable also carries sound signal so that an accessory speaker can be plugged into the base of the remote tube.

CHAIRSIDE TABLE holds chassis with controls and loud-speaker. Picture tube may be placed anywhere in the room within 25 feet. Connecting cable can go under the rug or around the baseboard.

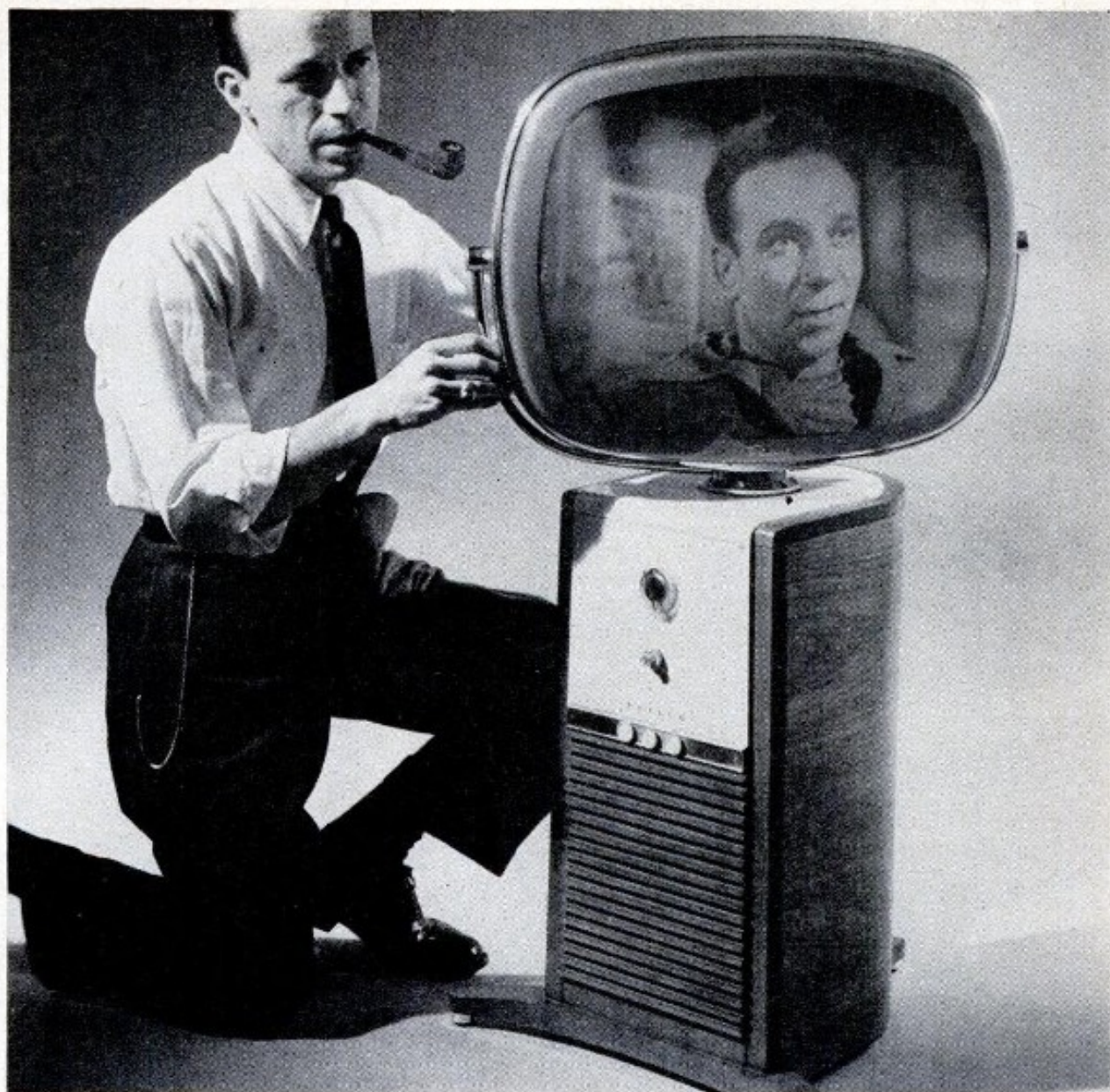


placement market simply because it offered no compelling reason for the customers to give up their old sets.

Starting with this fresh insight (fresh to the manufacturers, that is; the customers obviously knew it all along), Philco launched a two-year program. They went along with the rest of the industry in '57, packaging the then new 110-degree picture tube [PS, Nov. '57] in the conventional box-with-a-window.

Meanwhile their designers worked overtime, racing the calendar to have their big dream ready for '58.

It soon began to appear that they were stymied. If they were to keep their secret—and a competitive advantage—they had to get along with the standard picture-tube envelope. But they needed a more compact tube to fit their plans for a showy new appearance in TV receivers. They licked the problem—not by a technical discovery—but by snipping away at the space required by the electron gun in the tube neck. They gained a full two inches. The needed alterations in the tube envelope could be done in the privacy of their own plant. The result, according to Philco engineers, is

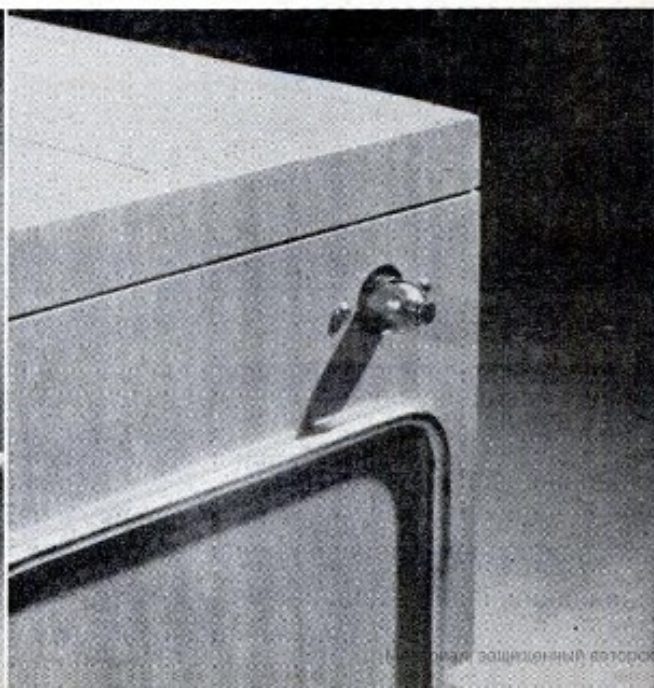
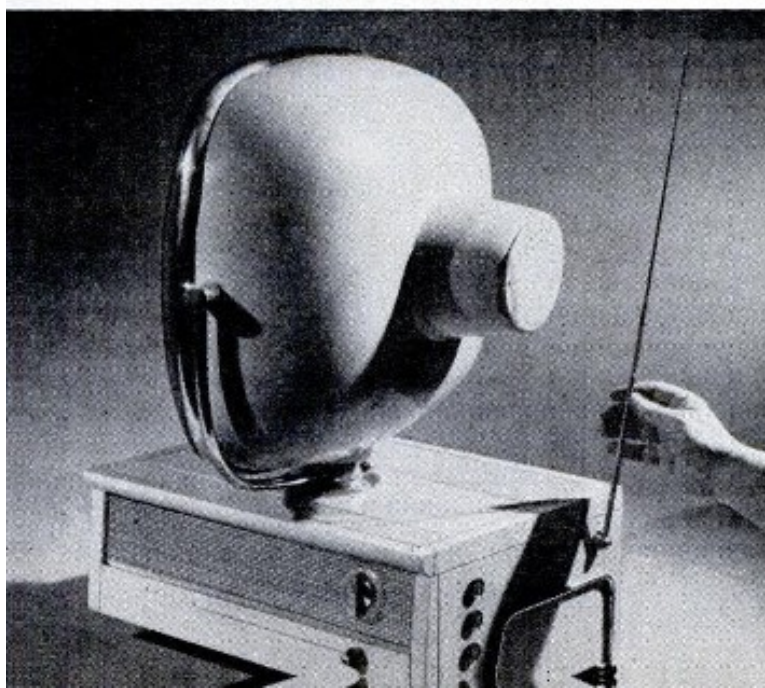


PICTURE TUBE IS ENCLOSED completely in a plastic capsule, swivel-mounted atop a pedestal base

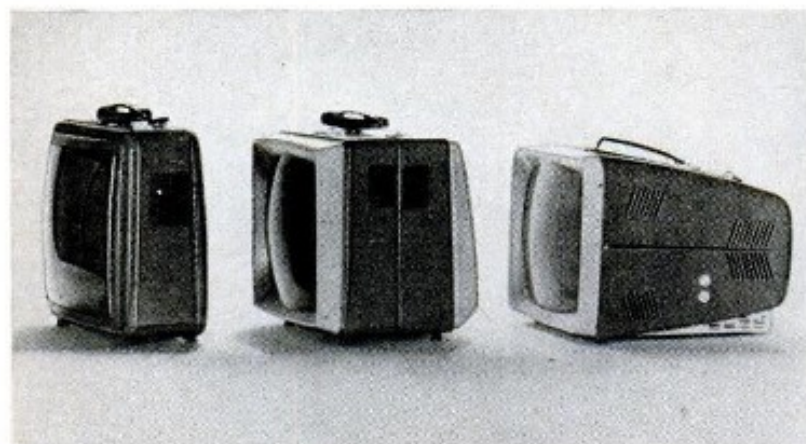
containing the chassis. An eight-inch speaker in the base gives you out-front sound.

COMPACT TABLE MODEL with swivel tube gives a full 21-inch picture, yet the package is small enough to be carried easily about the home.

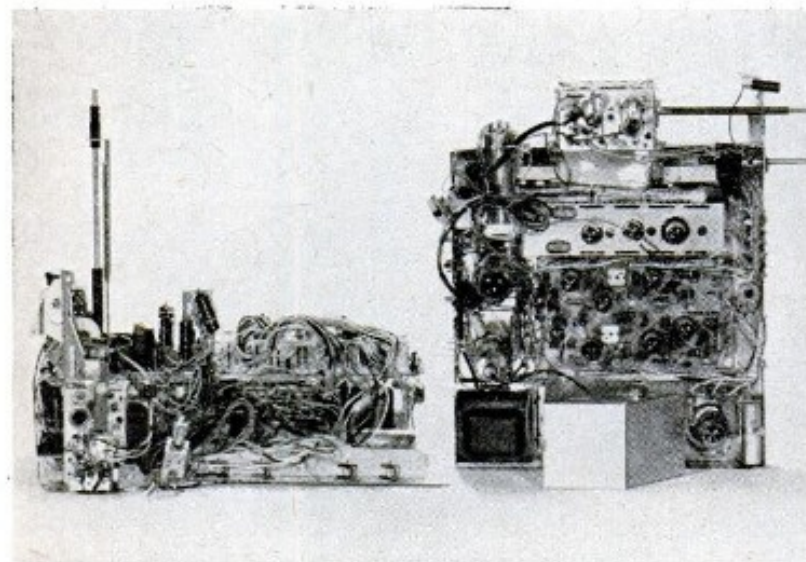
TELESCOPING ANTENNA replaces the former unsightly "rabbit ears." It collapses and disappears inside the cabinet when not in use.



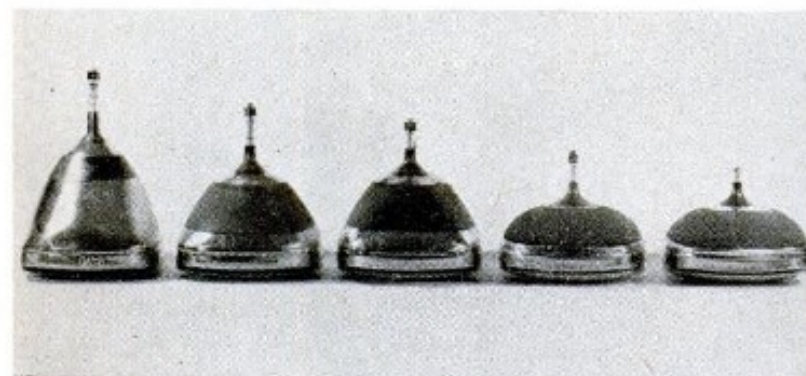
Not a picture-on-the-wall yet, but these sets go far in that direction



HERE'S WHAT HAS HAPPENED to portable television sets in only three years. On the left is the "Slender Seventener," a 17-inch set made possible by the new, shorter picture tube. It has a built-in, rotating antenna that serves as the handle.



CHASSIS HAD TO BE SQUEEZED, too, to fit into the new windowless cabinet. On the left is all that remains after engineers had packed all the "works" contained in the standard chassis (right) into suitable form for the new sets.



SHORT HISTORY OF THE SHRINKING PICTURE TUBE: Line-up of 21-inch picture tubes used in the past eight years shows how the length has steadily decreased. Latest 110-degree Philco tube is a full two inches shorter than last year's.

the shortest 21-inch picture tube ever produced for the consumer market.

Here was a tube compact enough to be capsuled in plastic and given an independent role in the design of a TV set.

Three versions of separate screen television are the result: a table model and a pedestal model with the picture tube swivel-mounted on top, and a two-piece job that lets you put the picture anywhere you like while the chassis and controls stay within easy reach of your armchair.

The new sets will be easier to service than the old-fashioned kind, Philco claims. The chassis slides out of the back of the cabinet like a file drawer to make tube replacement or other servicing a breeze.

Laboratory tests indicate that the picture-tube mount provides a greater margin of safety against implosion (bursting inward—opposite of explosion) than the usual mount inside the cabinet. Stray radiation that might interfere with nearby receivers is claimed to be less than the FCC minimum requirements.

There was an unexpected bonus along with the new picture-tube package—the face of the tube doesn't get dirty. Because of high voltage, a tube face usually collects dirt the way glass on a penny-candy counter collects fingerprints. It needs frequent cleaning to give a bright picture, which usually means removing the chassis from the cabinet or at best removing the covering safety glass. But with the capsuled tube, the dirt collects on the outside of the plastic cover where it can be easily wiped off. **END**

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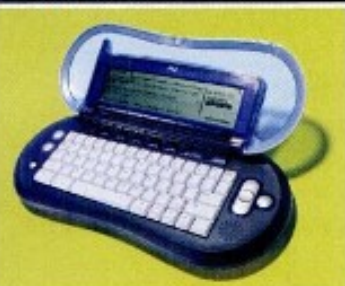


03>

SONY Gateway Tablet



INTEL Chat Pad



Browse on the Go

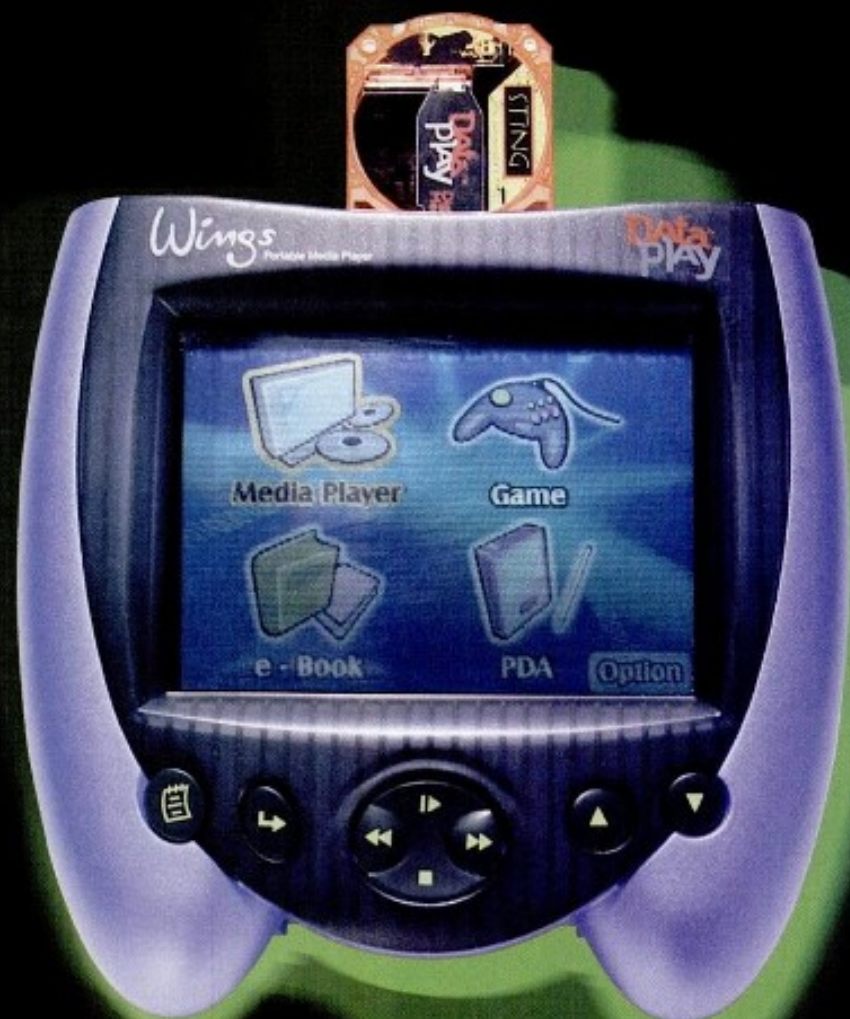
IF YOU WEREN'T convinced before that the Internet is meant for on-the-go access, the sheer number of devices that now let you do exactly that might make you reconsider. Sony's Wireless AV/IT Gateway tablet-style display device not only offers Web and e-mail access, it also lets you watch TV, DVD movies, and video from any other source hooked up to its base station. For the kids in your family, Intel's prototype Chat Pad offers access to e-mail and chat via a 900MHz wireless transceiver attached to your PC. The Chat Pad makes use of the PC's capabilities while maintaining privacy. When you want to go more than 100 feet from your home, strap on Hitachi's Wearable Internet Appliance. The device (left) clips to your belt; you wear a head-mounted display (top). You navigate the screen via an optical thumb-controlled mouse.

Table Topper

WEIGHING IN at only 100 pounds, the 50-inch RCA L50000 HDTV is one of the first tabletop models of its size, thanks to its liquid crystal on silicon (LCOS) display. Instead of converging three images—red, green, and blue—on a mirror at the back of the rear projection TV, the LCOS display uses red, green, and blue light streams reflected off separate imaging panels and recombined in a prism to form a single video image.

Boom Box Backpack

PORTABLE doesn't mean personal with JVC's RS-WP1 Sports Portable Backpack boom box. This 20-watt system features four full-range speakers with an active Hyper Bass Pro II circuit to improve deep bass sound, a digital AM/FM tuner with 45 presets, and a CD player with a 40-second anti-shock protection. The \$220 rugged Backpack is also weatherproof.



Disc Dreams

WHAT CAN YOU DO with Data-Play's quarter-size disc, which holds 500MB and costs just \$10? A lot, judging from the scores of prototypes on display. A couple of the most promising were Volan Design's e-book, which features two displays—one to read the book, the other to browse the Web—and Varovision's Wings portable media player, which plays back MPEG-4 movies and MP3 audio files.

VOLAN DESIGN Concept e-Book



Good Things Come in Small Packages

THE CHICKLET-SIZE SD card made a big splash this year, with many companies showing real and prototype products. Among the standouts were Toshiba's prototype desktop stereo system (lower far right) and Sharp's Zaurus MI-E1 PDA (right), which features MPEG-4 movie and MP3 music playback, Web browsing and e-mail, a 3.5-inch front-lit reflecting LCD, and 8MB RAM. Also on display were Panasonic's prototype SD card digital camera and Bluetooth personal networking cards, and Palm Computing's MP3 player, bar code scanner, and modem card concepts (far right from top).



SONY Satellite Radio



ALPINE Satellite Radio



Radio for All Places

ALL SYSTEMS ARE GO for digital satellite radio to deploy this summer. XM Satellite Radio (car antenna shown, left) will beam signals from space to car receivers like Alpine's CDA-7873 and Pioneer's DEH-P7300. Sony's DRN-XM01 travels from the car into your home. Sirius Satellite Radio, a XM competitor, will be available on car stereos from Clarion, Kenwood, and Panasonic.



AM, FM, or Internet?

INTERNET RADIO becomes another option alongside FM and AM on Philips' FW-i1000 mini-shelf system, the first to provide this feature. Using broadband cable or DSL always-on Internet connections, the FW-i1000 remains connected to the iM Tuning Service, which lets you sort through radio stations by genre, location, or language.

The Everything Communicator

IT'S A CELLPHONE, wireless two-way messaging and e-mail access device, Web browser, and PDA wrapped up in one tiny package. The Accompli 009 from Motorola measures 3.8 by 2.8 by 8.7 inches and weighs 5.7 ounces. But what makes this \$550 combo device stand out is its full keyboard and 256-color display. A \$75 speaker-phone accessory is optional.

Built to Browse

NOW YOU CAN GET Internet access on your TV without a set-top box. Panasonic, EspritV, and Zenith were all showing off TVs with Internet and e-mail functionality built-in. Just plug in a phone line and you're ready to browse. Panasonic's Internet TV (shown, \$799) will also come with a wireless phone jack and keyboard, and 8MB of memory for storing e-mail, weather, news, and stock information.



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Look Who's Talking!

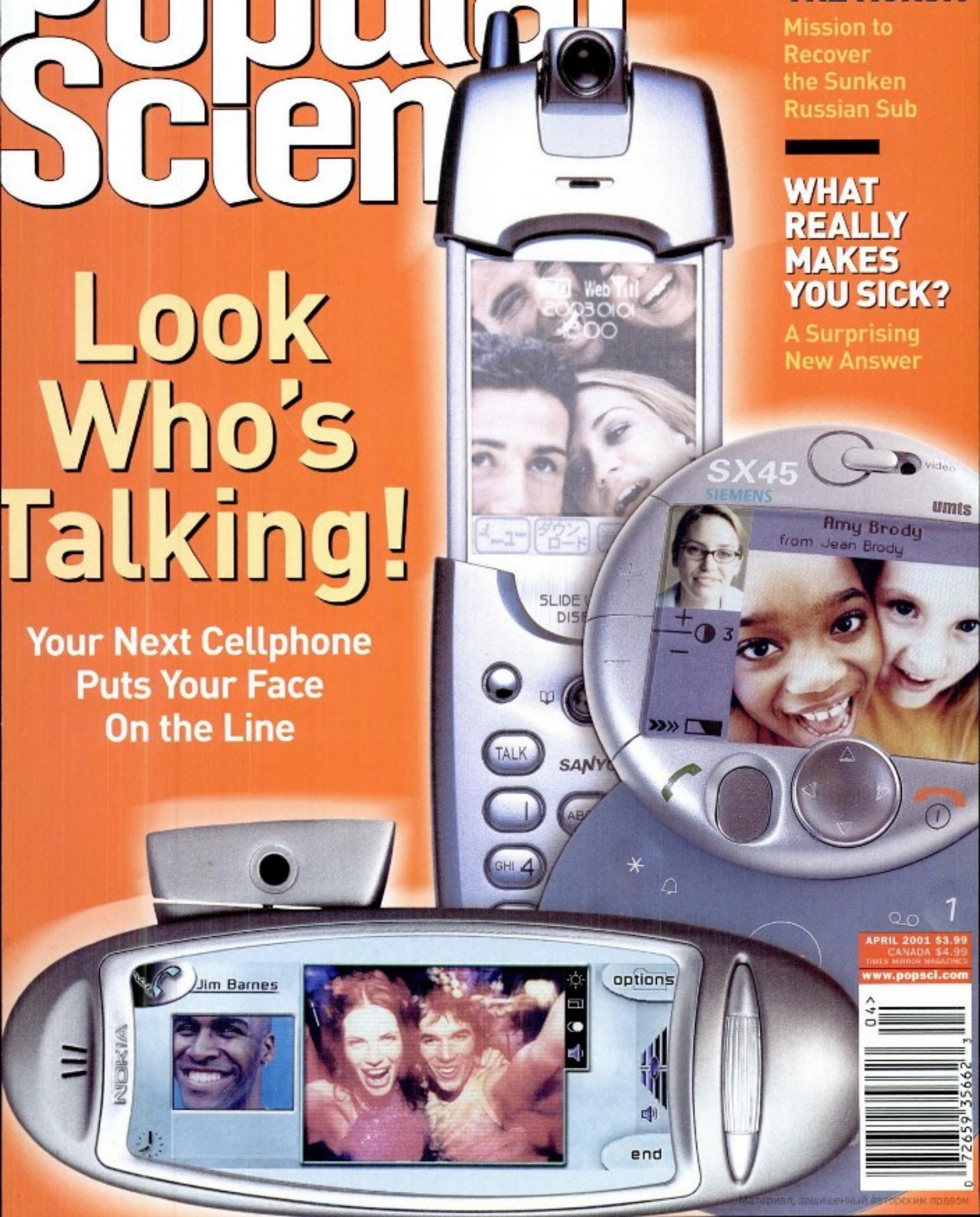
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The Hitchhiker's Friend

"GOING MY WAY?" Soon, French hitchhikers may not have to ask. The Peugeot Citroen Osmose concept has the driver's route map displayed on an exterior body panel (not shown). Passengers going in the same direction can just hop into the rear, outward-facing seats. This altruistic vehicle also has an airbag in its nose that deploys when a sensor detects errant pedestrians. The car, as a gas-electric hybrid, is also environmentally friendly. There are no productions plans yet. www.peugeot.com



Bang-up Box

YOU CAN'T judge a box by its cover—at least this one. The Microsoft Xbox's understated design belies a video game powerhouse on the inside. The VCR-size machine is capable of outputting digital audio and HDTV-resolution video, and supports broadband Internet access. With an optional expansion pack, the Xbox plays DVD movies. Price and availability have not yet been set. www.xbox.com

Smart Holster

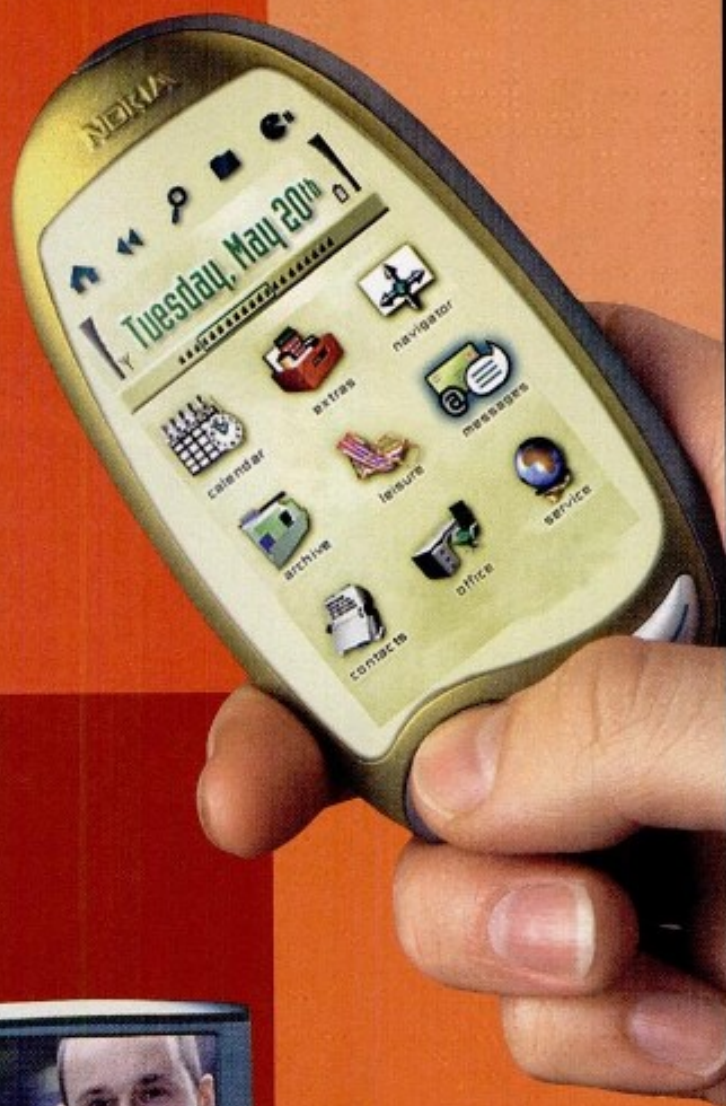
DESIGNED TO keep guns out of the hands of bad guys and children, Uncle Mike's Pro ID Holster is the first to use biometrics. Before a person can remove the gun, the holster verifies his or her fingerprint—the process happens in less than a second. Multiple users can be stored in the holster's memory. Unauthorized users, however, will not be able to remove the gun from the holster. The holster costs approximately \$500. www.uncle-mikes.com



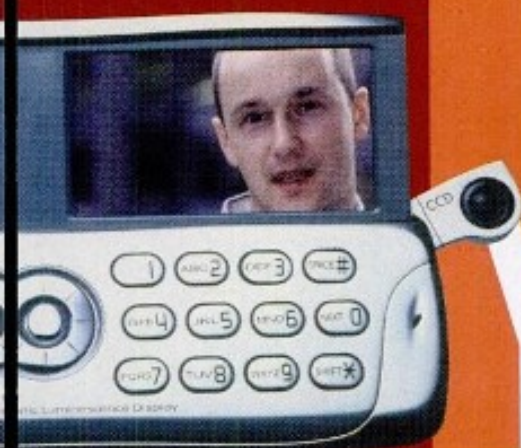
Prints to Go

SONY'S DCR-TRV830 Handycam Digital8 camcorder (\$1,300) turns into a portable picture studio when you attach its PVP-MSH portable color printer. The tiny printer creates 3.5- by 2-inch pictures from a video still on tape or a digital still image stored on the camcorder's Memory Stick. The printer is also a \$250 option for Sony's new DCR-TRV330, DCR-TRV530, and DCR-TRV730 Digital8 camcorder models. www.sony.com





"DO YOU THINK your father would prefer the navy blue tie with the maroon stripes, or the edgier one with the abstract pattern?" asks an anxious-looking woman as she holds the ties up to a tiny video camera. Several miles away, a couple comfortably ensconced in a booth at their favorite restaurant takes time before dessert to review the latest movie trailers and then buy tickets for the next show at the nearest theater. Across town, a man on the way to the airport receives word of a car accident enroute and automatically receives new directions on his car's console display. ■■■

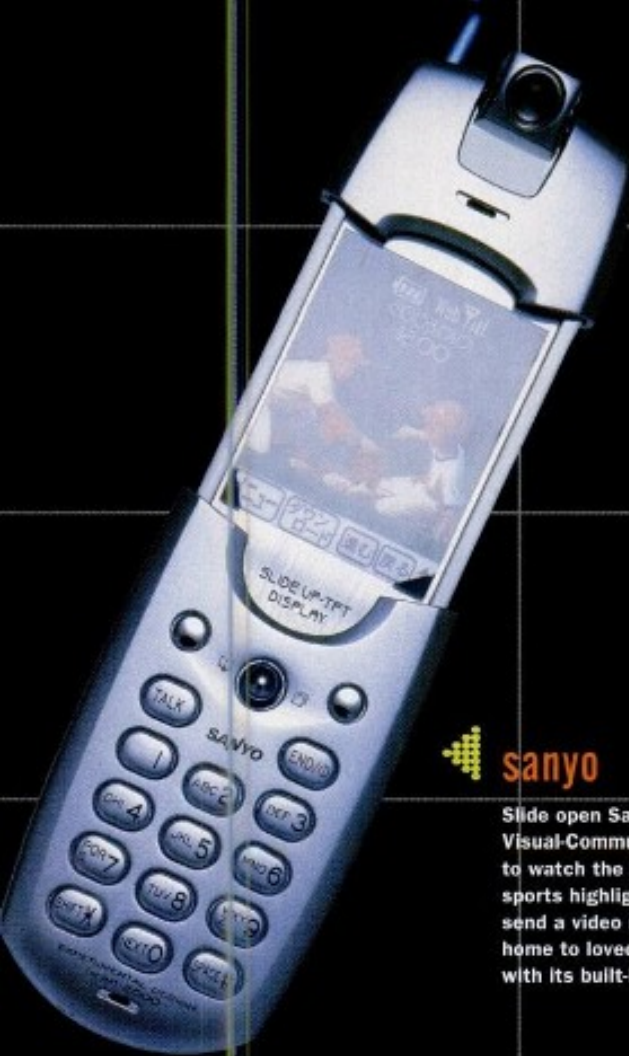


Your Next Cellphone



FORGET WHAT YOU KNOW ABOUT CELLPHONES—FUTURE PHONES WILL BE MULTIMEDIA MAVENS.

By Suzanne Kantra Kirschner



Slide open Sanyo's Visual-Communicator to watch the latest sports highlights, or send a video message home to loved ones with its built-in camera.

A CELLPHONE TIMELINE

FROM BASIC VOICE service to full-motion video, cellphones have come a long way.

1st Generation 1980s

Bandwidth Required 3Kbps

- Connection to laptop

2nd Generation 1990s

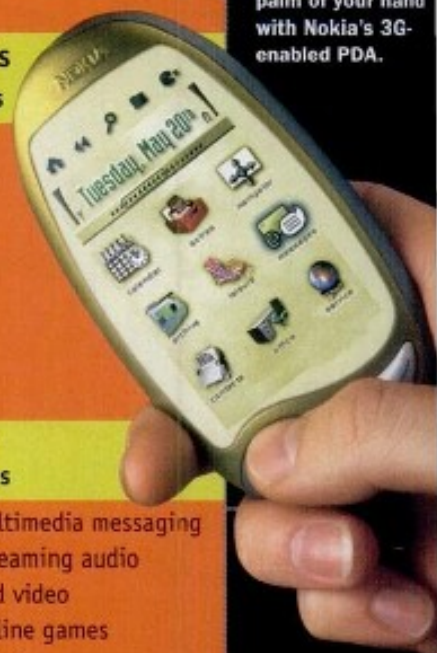
Bandwidth Required 9.6Kbps

- Messaging
- Basic Web browsing
- E-mail
- E-commerce
- Telemetry
- Vertical solutions
- Vehicle location

3rd Generation 2001

Bandwidth Required 384Kbps

- Full Web browsing
- E-mail with attachments
- Richer e-commerce
- Corporate intranet
- Multimedia messaging
- Streaming audio and video
- Online games
- Video telephony
- Music download



nokia

Put your e-mail access, Web browsing, calendar, and contacts literally in the palm of your hand with Nokia's 3G-enabled PDA.

riers in the United States are working on a means of prioritizing certain types of data, such as audio and video. Prioritizing seeks to properly weight the importance of speed to a given application—while you might be willing to wait a couple of extra seconds for an Excel spreadsheet to download, for example, any delays in transmitting a video clip can make for annoying viewing. A reliable method of prioritizing data packets will also enable carriers to split up voice calls into packets of data, instead of dedicating a full channel to each call. With packeted voice calls, the carriers will be able to handle at least twice the volume of calls, which will mean fewer times when you can't place a call due to an overloaded network.

Another key network technology of 3G will be its ability to pinpoint your location to within 50 meters. This capability was mandated by the FCC so that 911 operators can dispatch emergency services to callers who don't know where they are. But armed with

your location, carriers could also offer all sorts of location-based services, including driving directions, a list of the closest gas stations, and coupons for nearby retailers. There will, no doubt, be privacy issues associated with this aspect of 3G, but carriers are confident that by using an opt-in policy—in which you choose when or where or with whom to share location data—you will have some control over who knows where you are.

So what will your new 3G phone look like? Perhaps not like a phone at all. In fact, you'll likely have several 3G-enabled products eventually—a phone, an organizer, a game machine, a Web tablet, and maybe even your car. Unlike today's cellphones, many 3G devices will have a broad range of capabilities, including MPEG-4 video and MP3 audio decoding, voice recognition, and Bluetooth personal area networking—making them more akin to computers than phones. And the desire for bigger screens on these more versatile Web and video devices is apt

to grow, so not all of them will be as small as your current cellphone either.

One thing won't change: You'll still need to mate your 3G phone with a compatible 3G service, since not all carriers will use the same underlying network standards to achieve their goals. (Initially, 3G devices will work on the cdma2000 and UMTS network protocols.) As always, you'll need to pay attention to the coverage map of your 3G carrier, as it will expand over time. Eventually, there will be combination phones that will work on different types of 3G networks, just as some multi-mode phones today can handle calls over analog, digital, and PCS systems. And with Europe and Asia also moving toward 3G systems, truly global phones may become more commonplace as well.

But first, carriers and phone makers will need to produce on 3G's more basic promises, which have been talked about for more than a decade now. That, finally, should happen soon. Then it's your call. ♦

Within a few years, scenes like these will become commonplace, thanks to a revolutionary piece of portable technology: your cellular phone. Well, not your current cellphone. But the technology of the cellular phone—and the role that it plays in our lives—will be utterly transformed by something called 3G, or the so-called third generation of wireless telecommunications devices (after analog and digital phones). And if you think you know what it means to own and use a cellphone, you may have to clear your head. The 3G generation will come in a variety of shapes, sizes, and services, some of which hardly resemble the portable gabbers we know and love (or simply tolerate) today.

What exactly will 3G cellular mean? According to the standards already laid out by the International Telecommunication Union, 3G mobile devices will provide wire-line voice quality and very fast data rates for a wireless device—a minimum of 144Kbps, or roughly three times what most of us can squeeze out of a regular phone line with a 56Kbps modem. Those high data rates are expected to make practical a variety of audio and video services, such as music downloads, Internet radio, videoconferencing, and video e-mail. In addition to these functions, which will be provided via the new 3G networks, the pocket-sized devices we carry around will be packed with perks, such as color displays, removable storage media, and text-to-speech capabilities.

As with the changeover from first-generation analog cellular technology to second-generation digital technology, 3G's ramp-up from possibilities to realities will take some time. The first digital cellular phones of the early 1990s were large by today's standards and did just one thing: make or receive calls. Analog cellular modem cards did let you browse the Web with your laptop. But the phones themselves merely acted as dumb phone jacks. Today, you can purchase phones that are barely larger than chewing gum packs, can store hundreds of numbers, browse the Web, organize your day, and play

MP3 music. The first 3G handsets will start out with these capabilities and go from there.

But there's work to be done first. The foundation for these new 3G handsets and services lies in the networks. Service providers, such as AT&T Wireless and Sprint PCS, need to upgrade their existing cellular networks to support higher data rates, locate individual users, and prioritize packets of information so they can move from place to place much faster. When the first 3G services roll out later this year from Sprint PCS, you'll be able to browse the Web or receive various information services at speeds up to 144Kbps, or up to 10 times faster than the carrier's current capabilities. At busy times of day, you could expect speeds of perhaps 70- to 80Kbps. Sprint PCS says its network, which will use the cdma2000 (code-division multiple access) standard, should reach top speeds of 307Kbps by 2002, and go as high as 3- to 5Mbps by late 2003. At these high speeds you could listen to an audio clip or view a movie trailer streamed in real time from a Web site. And your connection is always "on"—you're connected at the press of a button without any waiting.

Sprint PCS, of course, isn't the only wireless carrier that will supply 3G service. AT&T Wireless is building a new wireless network based on the GSM (Global System for Mobile communication) standard, which should begin operating in 2002 and gradually move in three steps from speeds of 115Kbps to 2Mbps. The final standard will be UMTS (Universal Mobile Telecommunications System, which some providers call Wideband Code-Division Multiple Access), which will deliver speeds of 2Mbps. To benefit from each of these speed bumps as they become available, whether from AT&T or Sprint or someone else, you'll need a new 3G phone. And with color displays on the outside and lots of gadgetry inside, such phones may not come as cheaply as cellphones do today.

In addition to increasing the raw speed of their data deliveries, 3G car-

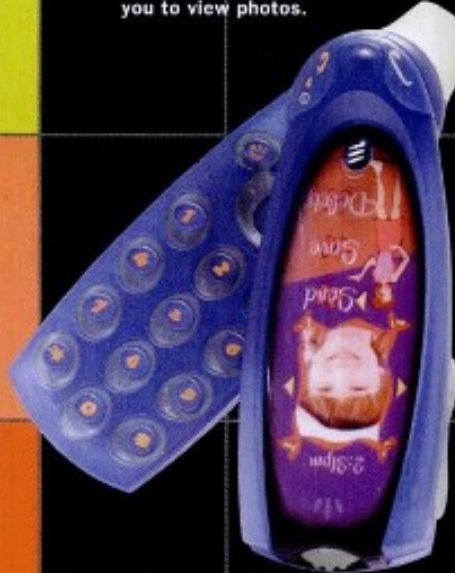


sanyo 

The Multi-Communicator looks and works like a regular cellphone when closed. But open it and it becomes a videoconferencing terminal.

ericsson 

Though designed primarily for voice calls, this palm-size cellphone's color LCD also enables you to view photos.



THE LOOK OF THINGS TO COME

TRY TO CLEAR YOUR MIND of any preconceptions you may have about what a cellphone is. The multifunction devices that will work on next-generation 3G networks will come in a variety of shapes and sizes.



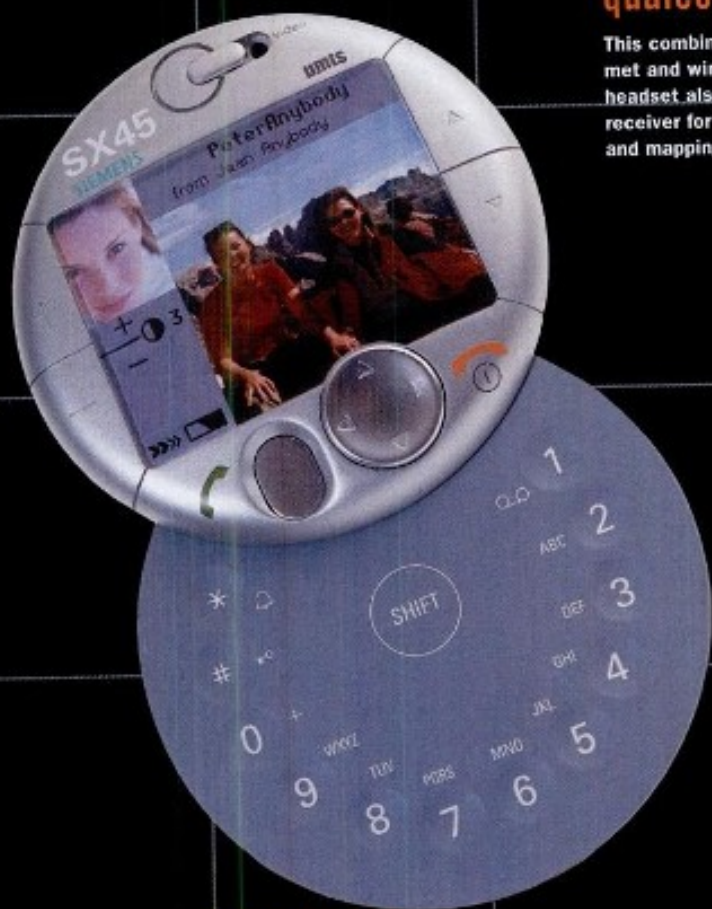
ericsson

Built for full-time use as a PDA, Ericsson's RX 1 doubles as a cellphone when you remove its wireless earpiece.



qualcomm

This combination bike helmet and wireless phone headset also features a GPS receiver for accurate routing and mapping information.



siemens

Hidden behind the SX45 videophone's sleek surface lies a surprisingly old-fashioned dial-pad design.

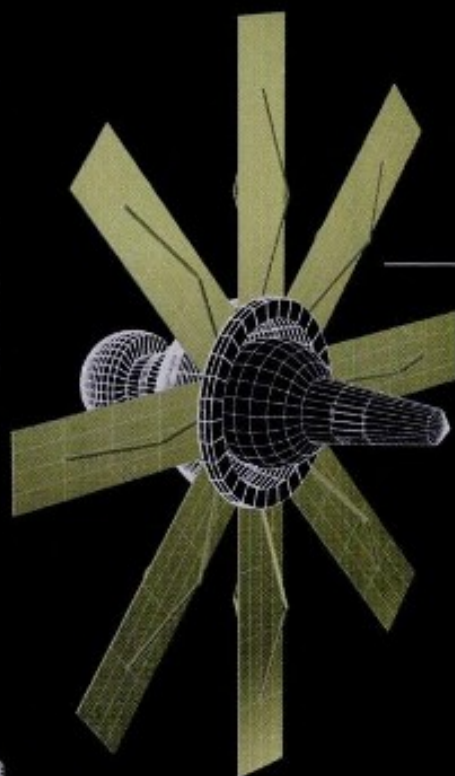
fujitsu

Rugged enough for the most hearty handling, Fujitsu's combination PDA-videophone makes its large color display the focal point.

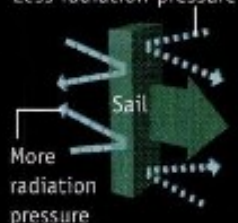


SEVEN SPACE DRIVES

WHILE WORK ON THE ESSENTIAL physics questions is in its earliest stages, that hasn't stopped scientists from thinking about how to harness potential new sources of spacecraft propulsion. Marc Millis of NASA's Glenn Research Center in Cleveland has suggested hypothetical space drives, shown in these POPULAR SCIENCE artist's concepts, to spotlight the problems and possibilities of physics yet to be discovered. While these designs would dramatically reduce or eliminate propellant, they would still be limited to travel close to light speed—except perhaps for the Induction Ring on page 50. If just one of these could be made to work, we'd have a breakthrough. But that is one big If.—M.D.

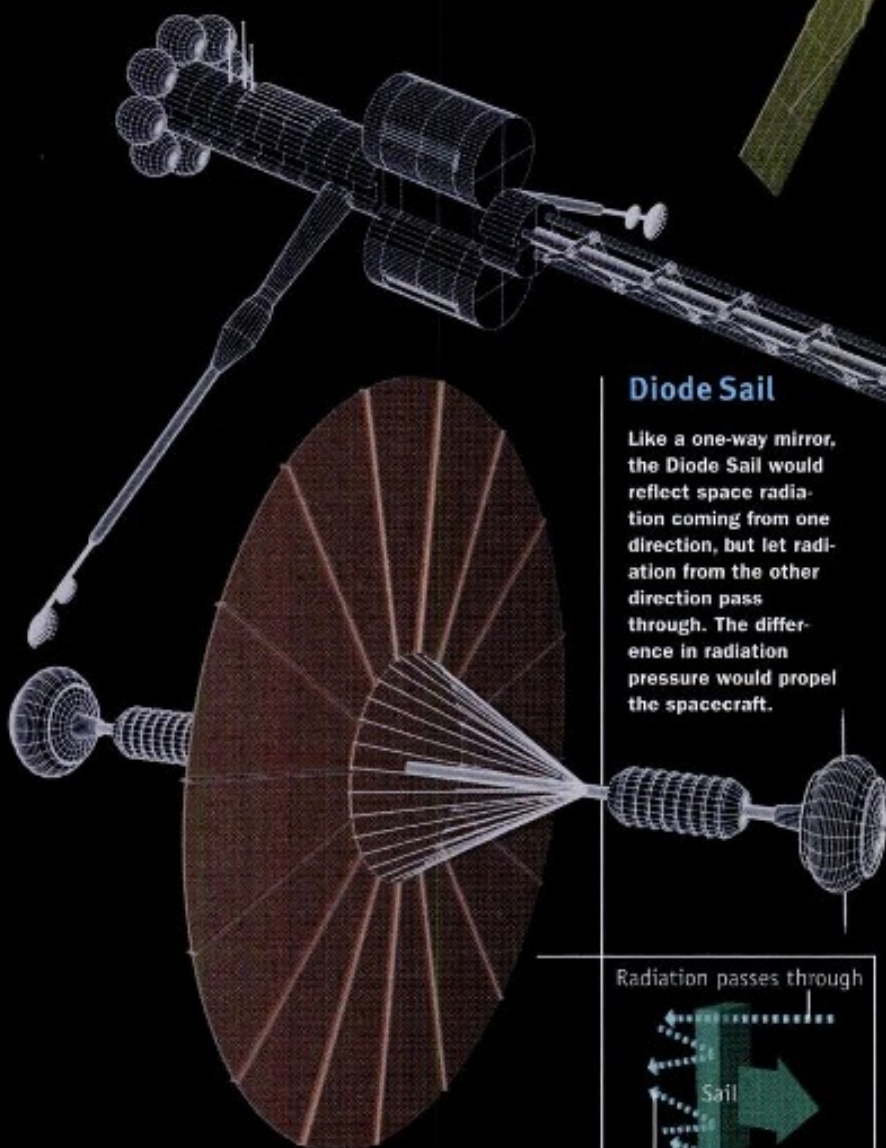


Less radiation pressure



Induction Sail

The pressure of radiation on one side of the Induction Sail is increased by some yet undiscovered means, and the pressure on the other side is lowered. The spacecraft moves toward the low-pressure area.



Diode Sail

Like a one-way mirror, the Diode Sail would reflect space radiation coming from one direction, but let radiation from the other direction pass through. The difference in radiation pressure would propel the spacecraft.

Radiation passes through



Differential Sail

Today's rockets zoom along thanks to collisions between the rockets themselves and their propellant. These collisions push the rocket in one direction and the propellant in the other. A hypothetical collision sail would work the same way. Imagine that space has some form of background radiation that is constantly impinging on the spacecraft—perhaps random particles or electromagnetic waves. If you could absorb the collisions in front of the vehicle and reflect the ones behind it, the spacecraft would be pushed ahead.

20,000 21,000 22,000 23,000 24,000 25,000 26,000

Disjunction Drive

One of the most speculative of speculative space drives. The name disjunction refers to the idea of separating the source of a field from that which reacts to the field (normally considered inseparable), resulting in forces on the part that normally reacts to the field.



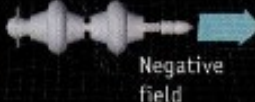
Induction Ring

An induction ring of negative energy— analogous to negative numbers—would warp space into a sort of bubble around the spacecraft (similar to the effect created by the Bias Drive, below).

Diametric Drive

Today, scientists know that interactions between matter and fields produce force. For instance, gravitational fields accelerate masses—like the apple that supposedly struck Newton. And electric fields accelerate charges. If a spacecraft could create an asymmetric field around itself somehow, then perhaps the field would propel the spacecraft. The Diametric Drive, a generic version of a 1957 "negative mass propulsion" concept, uses the interactions of a positive and negative field to propel the spacecraft.

Positive field



Bias Drive

The Bias Drive would alter the properties of space itself. For instance, it could reduce normal gravity on one side to produce thrust. Imagine a boat made from a block of wood with one pointed end and the other end indented. The block is floating on water, and you drop detergent behind it. Because soap changes the surface tension of the water, the boat is pushed along.



28,000

29,000

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50 INVENTIONS
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Let's Go to Mars

A STEP-BY-STEP PLAN
FOR MANKIND'S NEXT
GIANT LEAP

BY BUZZ ALDRIN

No Electric Bill!

HOW ONE FAMILY DOES IT

Katrina's Unsung Heroes

PM's Wish List

26 Great Gadgets

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FIX A TOILET, CUSTOMIZE YOUR PC,
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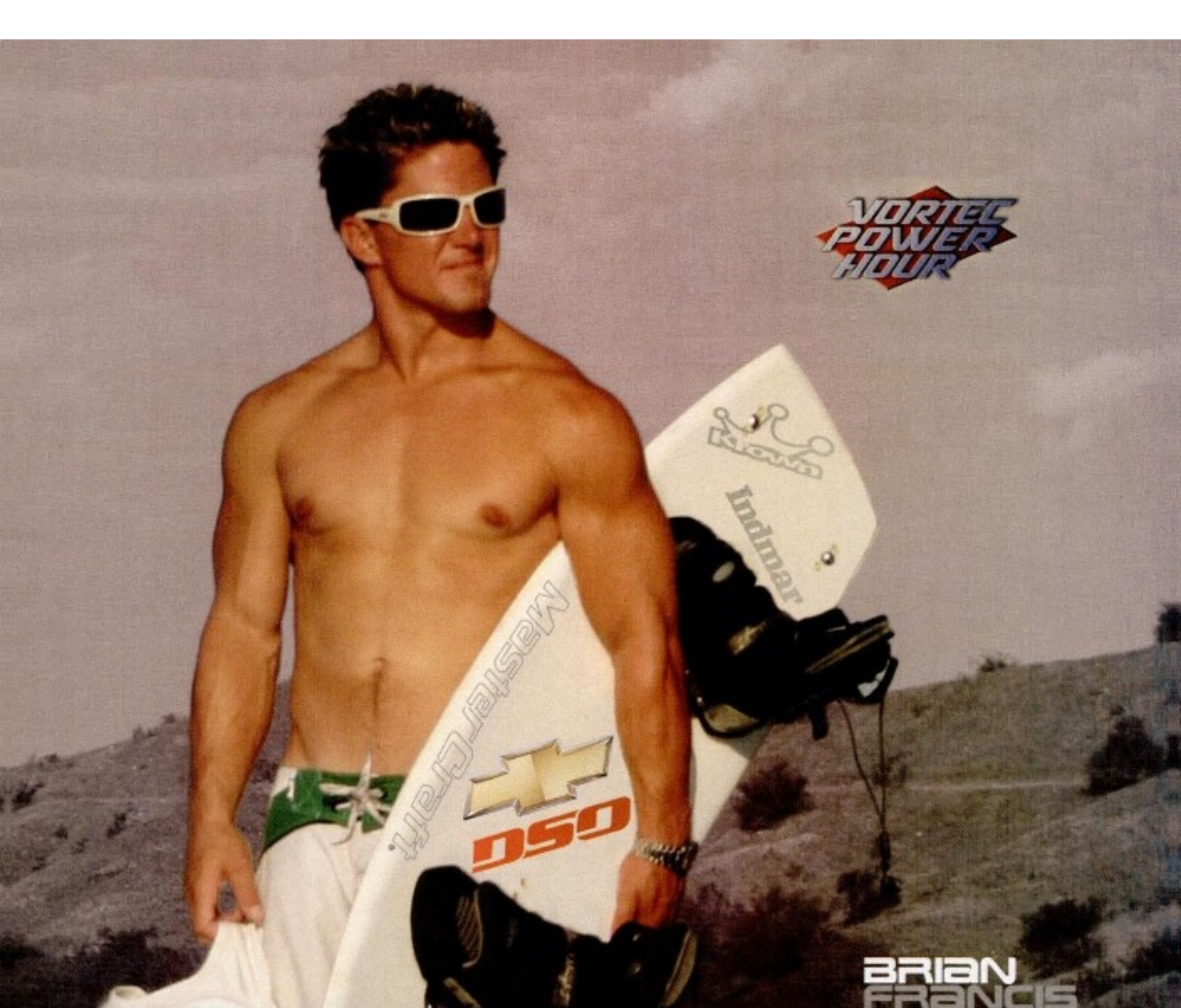


PM EXCLUSIVE:
Apollo veteran Aldrin
envisions this huge
craft permanently
shuttling astronauts
between Earth and Mars.



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ROADMAP

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SO FAR, NASA'S PLAN TO REACH THE RED PLANET HAS BEEN SHORT ON DETAIL. HERE, IN A PM EXCLUSIVE, APOLLO ASTRONAUT BUZZ ALDRIN UNVEILS HIS OWN STEP-BY-STEP PROPOSAL FOR MANKIND'S NEXT GIANT LEAP.

BY **BUZZ ALDRIN**
WITH DAVID NOLAND

The heart of Aldrin's plan is a craft he calls a **Cycler**, which other vehicles will link to in a multistage mission.

Mars lander, which docks with Cycler, transports astronauts to the planet's surface.

Habitat module in Cycler holds eight crew members and supplies for the five-month journey.

CEV acts as a taxi between orbiting Cycler and Earth.

Pressurized elevators transport astronauts between CEV and habitat module.

Nuclear reactor, which generates electricity for the craft, also serves to counterbalance habitat module.

In 1961, NASA was mulling over two possible flight plans to put a man on the moon. While agency officials argued the merits of Earth Orbit Rendezvous versus Direct Ascent, John C. Houbolt, a little-known engineer at the Langley Research Center in Hampton, Va., came up with a daring and ingenious alternative: Lunar Orbit Rendezvous. LOR, which would require two spacecraft to link up a quarter-million miles from Earth, initially struck many people—me included—as dangerously complex, even bizarre. But Houbolt stubbornly kept pushing his plan, and the elegant logic of LOR eventually won over the skeptics. On July 20, 1969, thanks to Houbolt's persistence, Neil Armstrong and I walked on the moon.

More than three decades later, as NASA

ILLUSTRATIONS BY **JEREMY COOK** PORTRAIT BY **MICHAEL KELLEY**

debates how to send humans to Mars, it's time once again to invoke the outside-the-box spirit of John Houbolt. NASA's latest thinking for a manned Mars mission is basically the Apollo program writ large: a massive disposable spacecraft that must be boosted from Earth to interplanetary velocity, and then slowed back down to alight on Mars. This flight plan has a huge energy requirement that translates directly into size, complexity and cost. Because each mission would be so extremely expensive, it's all too likely that such a program will lead to the kind of short-term "footprints and flagpoles" thinking that eventually killed Apollo.

We can do better this time. My blueprint for manned travel to Mars, based on reusable spacecraft that continuously cycle between Earth and Mars in permanent orbits, requires much less energy over the long term. Once in place, a system of cycling spacecraft, with its dependable schedule and low sustaining cost, would open the door for routine travel to Mars and a permanent human presence on the red planet. Its long-term economic advantages make it less susceptible to cancellation by congressional or presidential whim. In effect, this system would go a long way toward politician-proofing the Mars program.

► FORWARD MOTION

The key advantage of a permanently orbiting spacecraft, or Cycler, is that it must be accelerated only once. After its initial boost into a solar orbit swinging by both Mars and Earth, the Cycler coasts along through space on its own momentum, with only occasional nudges of thrust needed to stay on track. This dramatically reduces the total energy required for a Mars mission. Because conventional chemical rockets are so thirsty—the mass of the *Apollo 11* craft that carried us to the moon was more than 90 percent fuel on takeoff—every pound saved pays a huge dividend in the form of less propellant and smaller, cheaper boosters.

Once established in orbit with the long-term human survival systems, radiation shield and artificial gravity mechanism necessary for a lengthy space journey, the Cycler swings by Earth and Mars on a predictable schedule. Astronauts piloting "taxi" spacecraft, such as NASA's planned Crew Exploration Vehicle (CEV), rendezvous and dock with the Cycler as it passes Earth, using only the propellant necessary to accelerate the smaller craft. As the Cycler swings by Mars, the taxi casts off and brakes into Mars orbit, like a commuter stepping off a train. The Cycler, meanwhile, speeds on beyond Mars and eventually loops back toward Earth, ready for another passenger pickup.

The idea of a Mars-Earth Cycler has been around since the 1960s. In one early scenario, space habitats called CASTLES circled the sun in eccentric orbits that passed by both Earth and Mars. However, a Cycler using those orbits would take as long as 7½ years to complete a round trip between the two planets, and the planetary encounters would be irregular. A

reasonable Mars mission schedule would have required up to six such Cyclers in staggered orbits.

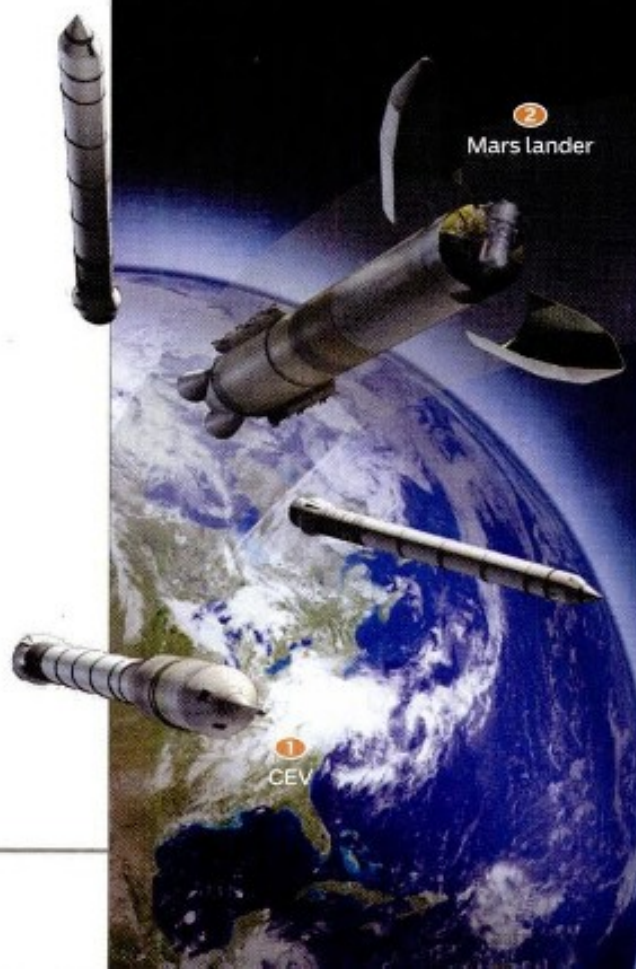
It seemed to me there must be a more efficient way. Using techniques of orbital mechanics I'd developed at MIT during my Ph.D. studies, as well as firsthand insight gained by my flights on *Gemini 12* and *Apollo 11*, I calculated that the time could be significantly reduced by using gravity assist from Earth to slingshot the Cycler into a better orbit.

LONG-RANGE PLAN ►

Decades of planning and development will set the stage for manned Mars missions, resulting in a permanent interplanetary transportation system in 2036.

FIVE-MONTH JOURNEY ►

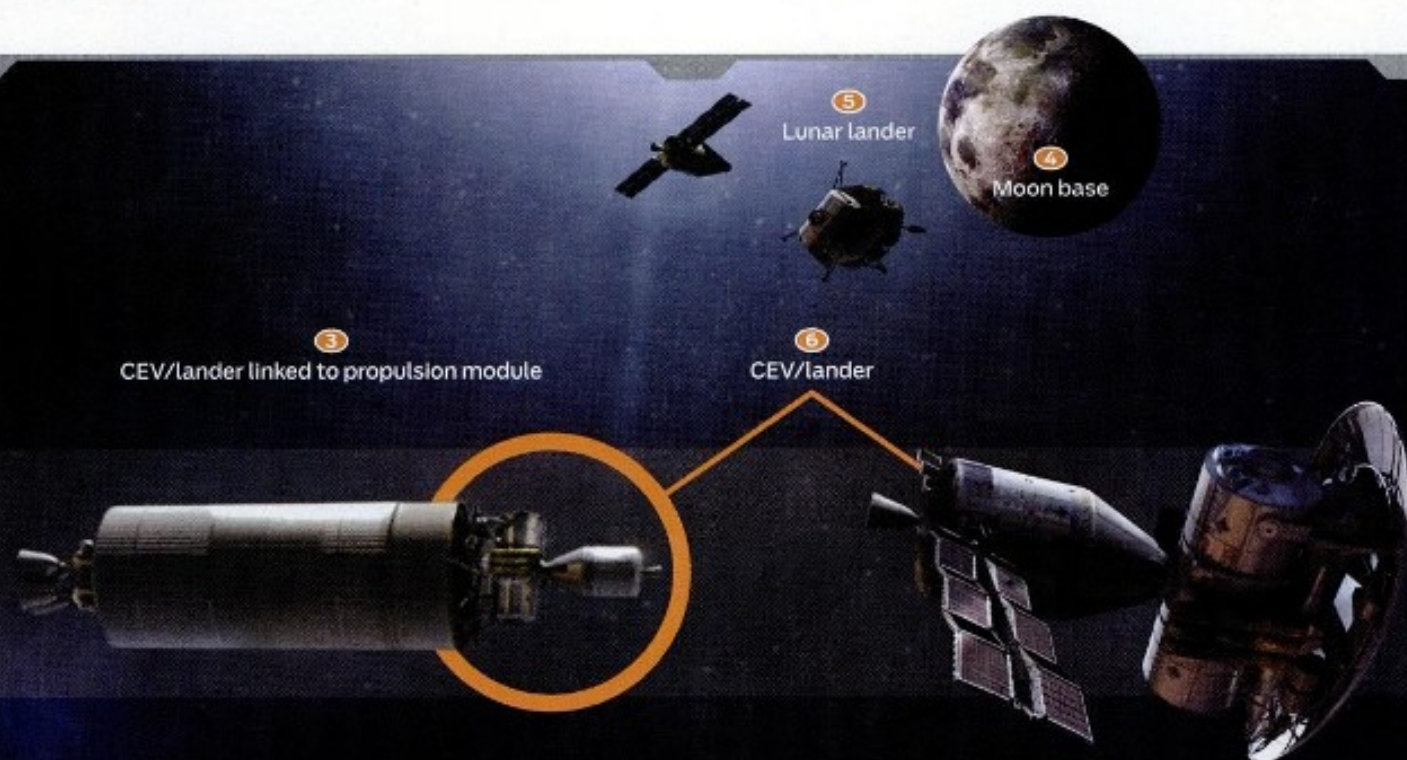
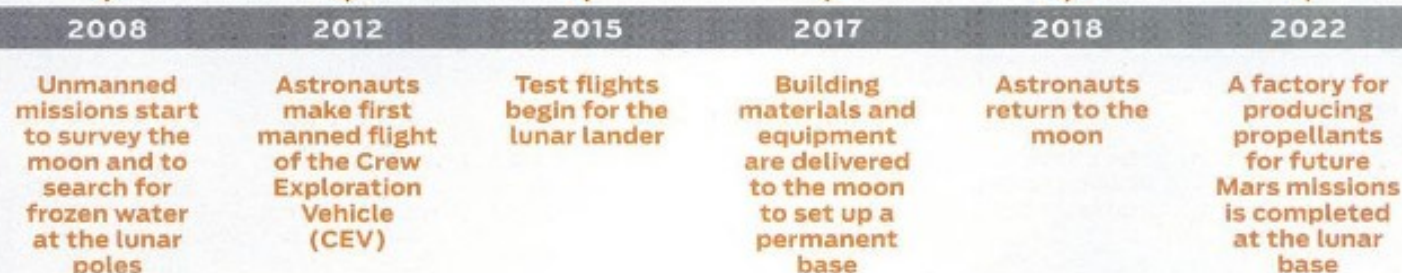
Once the infrastructure is in place, the journey from Earth to Mars will take five months to complete, and involve a wide range of vehicles.



“Gravity assist” is a well-proven technique for interplanetary flight, routinely used on unmanned probes like Voyagers 1 and 2, Cassini-Huygens and Galileo. If a spacecraft flies close enough to a planet, its orbit will be bent by the planet’s gravitational field. The process can be likened to a ball (the spacecraft) bouncing off a wall (the planet). If the wall is moving toward the ball, the rebound speed will be higher than the speed prior to impact. Similarly, if

the wall is angled, the ball will change direction. In either case, a great deal of energy can be added to the spacecraft with no expenditure of propellant.

By taking advantage of gravity assist from Earth, and to a lesser extent from Mars, I was able to plot a Cyclor orbit with a round-trip period of just 26 months. The Cyclor would take only five months to reach Mars, comparable to the fastest transit times that NASA is now considering.



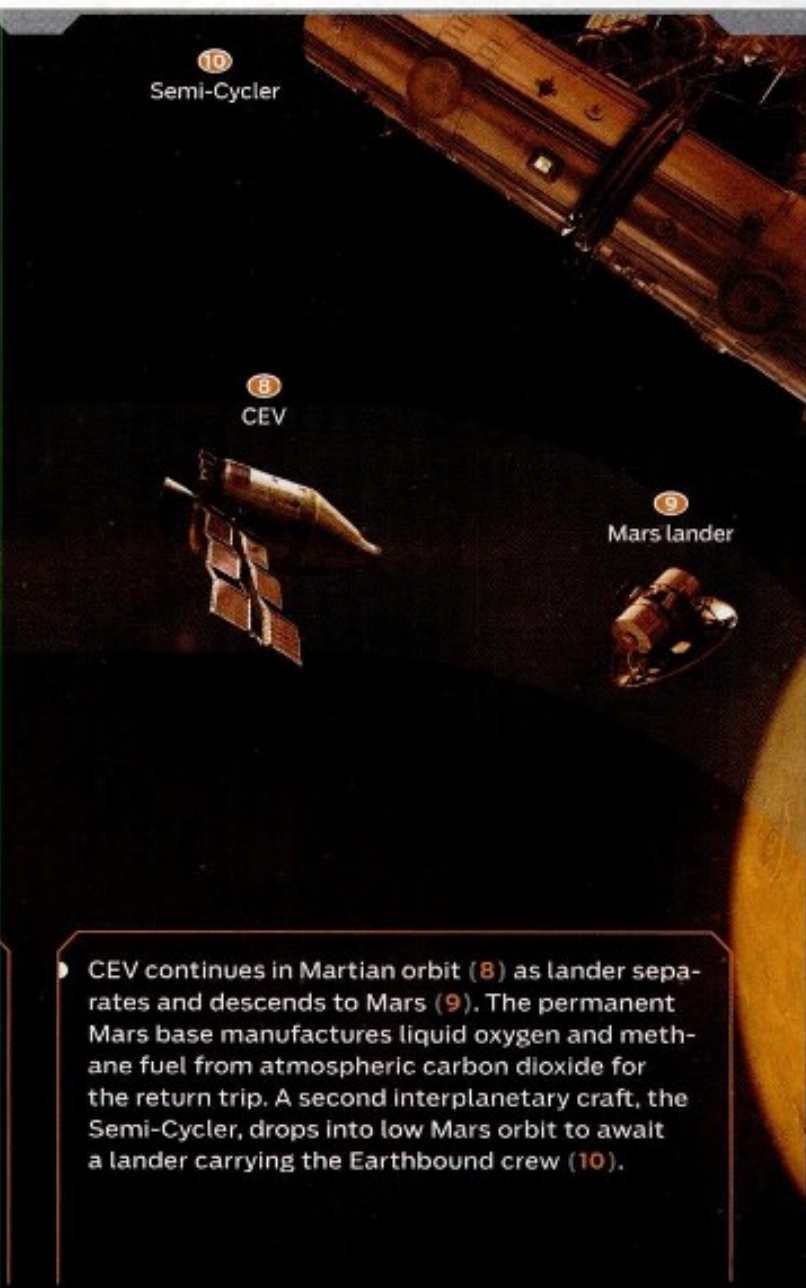
CEV with eight-man crew is launched into low Earth orbit (1). After docking with Mars lander and propulsion module (2), previously launched from Earth, CEV burns into highly elliptical “marshalling” orbit that carries it halfway to the moon (3). There, its tanks are topped off with liquid oxygen and hydrogen fuel delivered from the moon.

A permanent moon base (4)—established by numerous flights of lunar lander (5) and unmanned freighter craft—manufactures fuel from lunar ice. After a 7-minute Earth-departure burn, CEV/lander separates from propulsion module (6) and 10 days later docks with passing Cyclor craft a million miles from Earth (next page).

A downside of the gravity-assisted Cyclor concept, however, is that the vehicle flies by Mars at quite a high speed, up to 27,000 mph. This velocity is not a showstopper on the outbound leg, where the CEV taxi craft would aerobrade, relying on the friction of the Martian atmosphere to slow down without using any propellant. But departing Mars for the leg back to Earth, the craft would need a large amount of propellant to catch up with the speeding Cyclor.

To circumvent this problem, I envision a hybrid craft called a Semi-Cyclor for the return leg. Like the Cyclor, the Semi-Cyclor would shuttle between Earth and Mars in a gravity-assisted orbit. But it would use aerobraking in the Martian atmosphere to slow down, interrupt its cycle and loiter for four months in a wide, lazy orbit around Mars, waiting to pick up the next Earthbound taxi. With a flyby velocity as low as 5000 mph, the Semi-Cyclor would be an

2028	2030	2032	2034	2036	2038
Unmanned flight to the surface of Mars transports components for propellant manufacturing plant	Exploratory mission is made to Mars's moon Phobos using lunar lander	Astronauts return to Phobos and, using Mars lander, descend to planet's surface for a 10-day stay	Semi-Cyclor assembled in Earth orbit is accelerated into Earth-Mars orbit	Launch of Cyclor into orbit and manned mission results in first 44-month stay at Mars base	Next mission catches Cyclor as it once again nears Earth, initiating routine missions at 26-month intervals



easy target for a low-propellant taxi rendezvous. Once it discharged the spacecraft to aerobrake into the Earth's atmosphere, the Semi-Cycler would be slingshot on a circuitous 14-month route back to Mars for another run.

One drawback of the Semi-Cycler is its need for propellant to accelerate out of Martian orbit back toward Earth. But compared to a direct flight in a conventional rocket, the overall savings are still substantial. A second drawback

is a longer transit time back to Earth, about eight months. But with the help of top engineers at NASA's Jet Propulsion Laboratory, Purdue University and the University of Texas, I am continuing to refine Semi-Cycler orbits to achieve optimum transit times, orbital periods and flyby velocities.

TECH SUPPORT

The Cycler itself is only the capstone of a long process of space development. NASA's proposal to revisit the moon using a CEV is a first step in the right direction. A second step would include exploratory flights to Mars's moon Phobos, which would serve as an early launchpad to the planet's surface. Creating a sustainable Mars transportation system, though, would require a huge support infrastructure.

A permanent base on the moon would use lunar ice to produce liquid oxygen and hydrogen fuel for the taxi's sprint to catch the Cycler. NASA's Clementine and Lunar Prospector missions in the 1990s discovered tantalizing hints that ice might exist deep inside craters near the lunar poles.

Liquid oxygen and methane fuel for the outbound taxis, Semi-Cycler and a Mars lander/ascender would be manufactured at a permanent base on Mars. The propellant plant would combine a feedstock of liquid hydrogen with carbon dioxide from the Martian atmosphere. If frozen water can be mined from under the poles, where recent Mars rover missions have detected it, hydrogen could also be produced.

A fleet of unmanned freighters would resupply the Cyclers and surface bases on Mars and the moon. Because they can be launched years in advance, instead of chemical rockets the freighters could use the efficient, low-thrust ion-drive engines, too slow for manned travel, that were tested on NASA's Deep Space 1 probe in 1998.

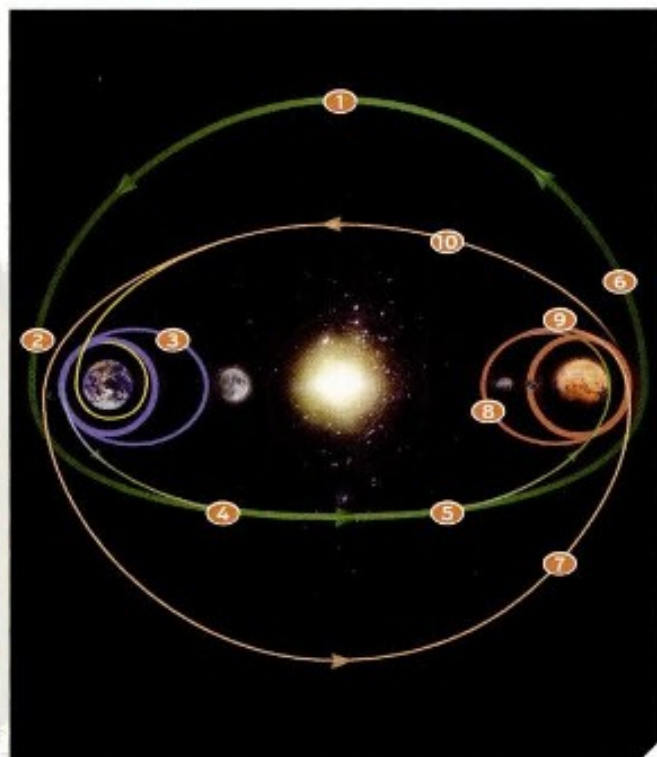
OUTBOUND JOURNEY

How would the Mars Cycler System work on a practical level? Fast-forward to the year 2040, and climb aboard for a five-year hitch in the Red Planet Corps.

You and your fellow astronauts (I envision a crew of about eight) launch from Earth in a CEV-type taxi spacecraft fueled by a high-performance hydrogen booster. While in low Earth orbit, your CEV docks with a Mars lander and a propulsion module previously launched from Earth. Linked up in this Apollo-style triple unit, you burn into a highly elliptical six-day "marshalling" orbit around the Earth that takes you roughly halfway out to the moon. There, you join up with a resupply ship carrying a load of liquid oxygen and hydrogen fuel manufactured on the moon. You top off the tanks of your propulsion module so that you can catch up with the Cycler, which is now fast approaching Earth.

The Trans-Mars Injection burn lasts about 7 minutes at an acceleration of about 2 g's. If you've done it right, you rendezvous with the Cycler about 10 days later, a million miles out from Earth. The CEV and Mars lander separate

THE ORBITS



The Cycler's eccentric orbit carries it close by Earth every 26 months (1). Earth's gravity adds energy to the craft, slingshotting it into a five-month trajectory to Mars (2). The CEV accelerates out of its six-day "marshalling" orbit around Earth (3) to rendezvous with the Cycler (4). As the spacecraft approaches Mars, astronauts detach the CEV from the Cycler (5), which then slingshots back to Earth (6). It arrives 21 months later. The Semi-Cycler takes a circuitous 14-month route from Earth (7) and aerobrakes into a slow four-month orbit around Mars (8)—making it an easy target for the departing CEV (9). The Semi-Cycler then accelerates out of Martian orbit for the eight-month return trip (10).

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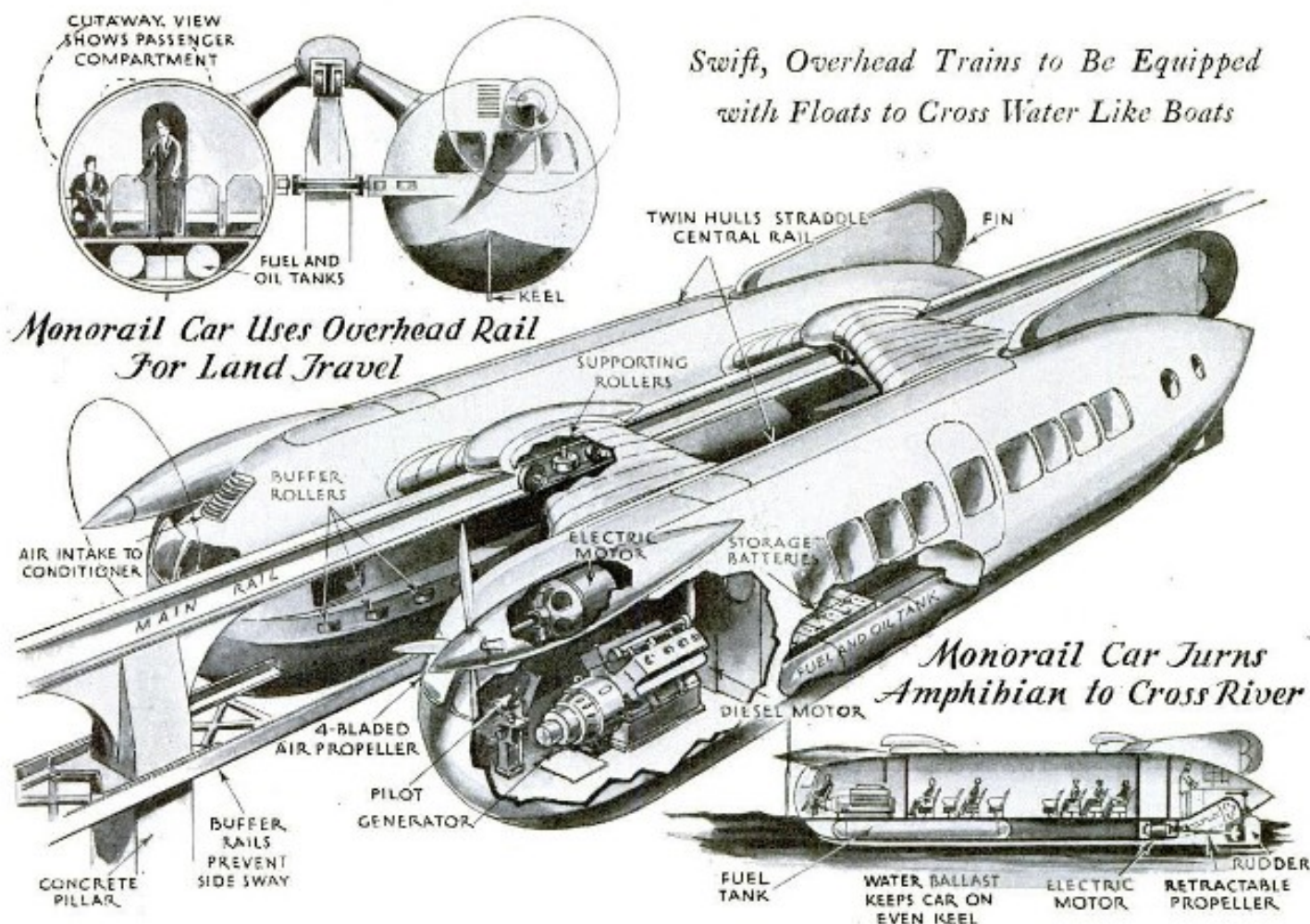
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SEE PAGE 33

NEW INVENTIONS • MECHANICS • MONEY MAKING IDEAS
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Twin Amphibian Cars for Monorail



AMPHIBIAN trains that can whiz above desert sands on an overhead rail, or plunge into the water to ford a river, are contemplated by the Soviet Government in an amazing plan to tap mineral wealth in Turkestan. They are to travel three projected monorail lines of unprecedented design, totaling 332 miles in length and crossing deserts and rivers.

A single overhead rail on concrete standards could be erected at low cost along these routes, engineers estimate. Air-propelled cars with twin, cigar-shaped hulls could straddle the track and glide along it, at speeds reaching 180 miles an hour, according to calculations based on tests of models at Moscow. The cars would be equipped with Diesel-electric drive, and

each one would carry forty passengers or an equivalent freight load. Where the longest of the projected routes crosses the river Amu-Daria, a mile and a quarter wide, it is proposed that amphibian cars be used. On arriving at the shore the cars would leave the overhead rail and cross the river as a boat. Soviet engineers are reported already surveying the route.

DRIVER'S SCARF HEATED BY CAR



A heating element, woven into this scarf, is attached to car's battery at dashboard outlet and electrically heated

AN ELECTRICALLY heated scarf for the comfort of open-car drivers on cool evenings has been devised by a Los Angeles, Calif., inventor. An electric heating element is woven into the fabric, and a flexible cord attached to one end of the scarf is plugged into an outlet in the dashboard and connected with the electrical system of the automobile, exactly as a cigarette lighter is worked.



CAMERA ON GUN TO TRAP CROOKS

PHOTOGRAPHIC identification of fleeing criminals may be obtained with a recently perfected camera which is attached to a pistol or rifle and worked by the gun's trigger. The lens used can work at an opening of F/3.5, which permits the camera to be used in comparatively poor light and at high speed. The small negatives are sharp enough to be enlarged.

The New Threat: Skyscraper Fires Page 53

POPULAR MECHANICS

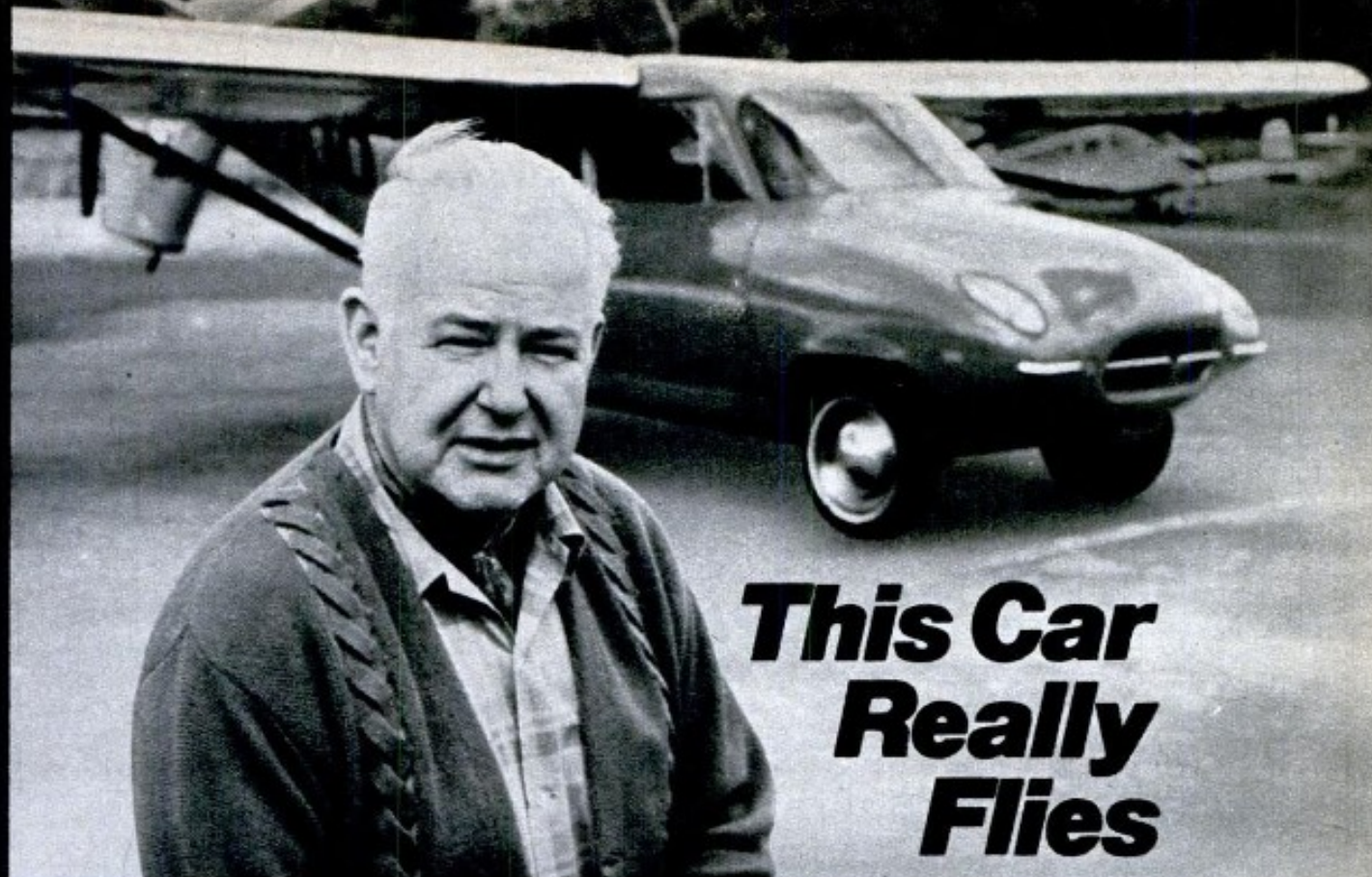
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*'It Sprouted
Wings... So I
Flew It'* Page 87

**23 PAGES—GET MORE FUN OUT OF SUMMER
AT HOME FOR VERY LITTLE MONEY** Page 123:

3 Ways to Make Your Garage an Outdoor Family Room
■ Diving Deck for Above-Ground Pools ■ **How to Wire
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Handle a Crowd ■ **Rollaway Wall Makes Your Driveway
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Basketball, Dancing—Under Your Own Back-Yard Lights**



This Car Really Flies

By BOB GRANT

A FLYING AUTOMOBILE that sells for less than some luxury cars? It will happen if Moulton (Molt) P. Taylor has his way. His Aerocar III has been certified by the FAA for sale to the public, and could be produced with a price tag as low as \$10,000. The only machine of its type so certified, the Aerocar is the result of two decades of development at Taylor's little shop in Longview, Wash.

The trouble with today's private planes, says Taylor, is that "when you get where you're going, you aren't where you want to be! The Wright Brothers made a serious omission. A bird that can't walk would starve to death. Henry Ford, on the other hand, came up with a thoroughbred automobile but corralled us from the start—it's limited to highways."

The Aerocar III, a sporty little two-seater that can roll as well as fly, is basically a sleek compact fiberglass car and an aluminum flight component of wings and tail. When you land, you get out and pull a few pins and bolts. The wings fold and wheels extend to turn the flight component into a trailer. You can park it at the airport while you buzz off on business or tow it home and store

it in the garage until you're ready to fly.

Aerocar might be the answer if you have to commute anywhere. It will carry 500 pounds—two people and 100 pounds of baggage. Empty weight is about 1500, comparable to a standard four-place airplane. Some 1100 pounds is the automobile/cockpit. Gear necessary to run on the road—clutch, transmission, differential, horn, turn signals, headlights—make up about 300 pounds. It's very useful weight back on the ground.

Changing from plane to car and back takes about 10 minutes to do manually. A production model incorporating hydraulic mechanisms would do most of the work at the touch of a button.

Aerocar could make learning to fly easier than learning to drive. It is an enormously stable craft and has certain other advantages inherent in its design. By putting the prop in back, it flies through undisturbed air.

"Man has dreamed about a flying automobile for years," Taylor comments. "and Walt Disney even made a movie about one." Perhaps the Aerocar will be a dream come true. ***

(For a PM flight report, turn the page)



Photos by Bob Grant



THE FLYING AUTOMOBILE attracts startled glances in downtown traffic. It handles easily even when towing the flight trailer. A special pylon is said to keep the trailer steady up to 70 mph and in 40-mph crosswinds



'I Flew It'

By FRANK A. TINKER

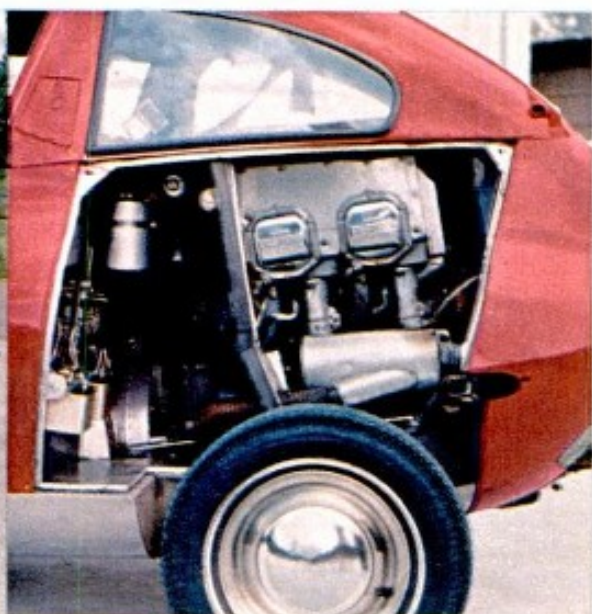
"IN 15 MINUTES we'll be looking down on this," said Molt Taylor as we drove past a restaurant on the way to the airport. He was right; in that time we had fixed the Aerocar III's wings in place and taken off. Try this on any other combination sports car and airplane!

My job was to test the Aerocar in the air, and, as a professional pilot weaned on distrust of any aircraft not factory built and strictly conventional, I had some qualms. In the first place, the contraption Taylor had wheeled out of his little shop in Longview, Wash., appeared to be primarily an auto. It proved to be exactly that as we drove to the airport. Except for several odd controls and instruments, the interior looked very much like a sporty compact.

The noise level was higher than an ordinary car as we drove away, but that was expected and did not approach the uncomfortable. The only



BUG BECOMES BIRD as two pins are driven in place to secure flight component and wings unfold for takeoff



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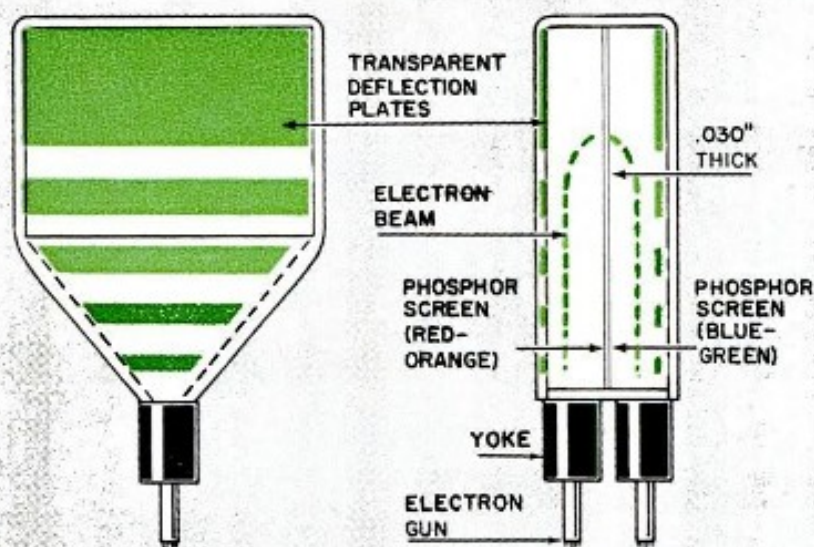
BREAKTHROUGH: you can watch both
sides of this flat-tube color TV!

Bonus Tearout! Wall Fasteners





Fantastic new portable color tv set has flat picture tube you can watch from both sides. New flat-tube development is first step toward practical hang-on-the-wall television for your living room. BY Larry Steckler

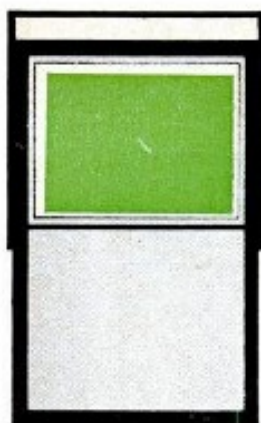


THINNEST COLOR picture tube gives up its secrets in detailed PM sketches

FLAT TV PICTURE TUBES ARE REALLY HERE. There are both color and black-and-white versions. I know. I've seen them in action. I've held them in my hands. And you'll soon be seeing them in a new breed of portable TVs sporting a famous maker's label around the end of this year.

Now settle back and we'll let you in on the news. Out in the suburbs of Los Angeles are the business offices of the Intertel Corp. And inside these offices some remarkable things have been going on. They've developed a flat color-picture tube like the one diagramed above. It has a 6-inch screen that gives a perfectly rectangular viewing area, $4\frac{3}{4} \times 3\frac{1}{2}$ inches. Best of all it's a tiny $2\frac{3}{8}$ inches thick. When combined with a transistor color TV chassis it makes a color set that's a mere $10 \times 6 \times 3\frac{1}{2}$ inches, weighs six pounds and costs about \$200. Just the right size to take along on your next trip. They've come up with a monochrome (black-and-white) portable too, and it's even smaller— $9 \times 4\frac{1}{2} \times 2\frac{1}{4}$ inches—and costs \$150.

While only small-screen versions of the flat picture tubes have been built so far, there is no limit to the size tube that



can be built. Scaling-up, a 23-inch rectangular tube would be about 4 inches thick. You could certainly hang it on your living room wall and probably will.

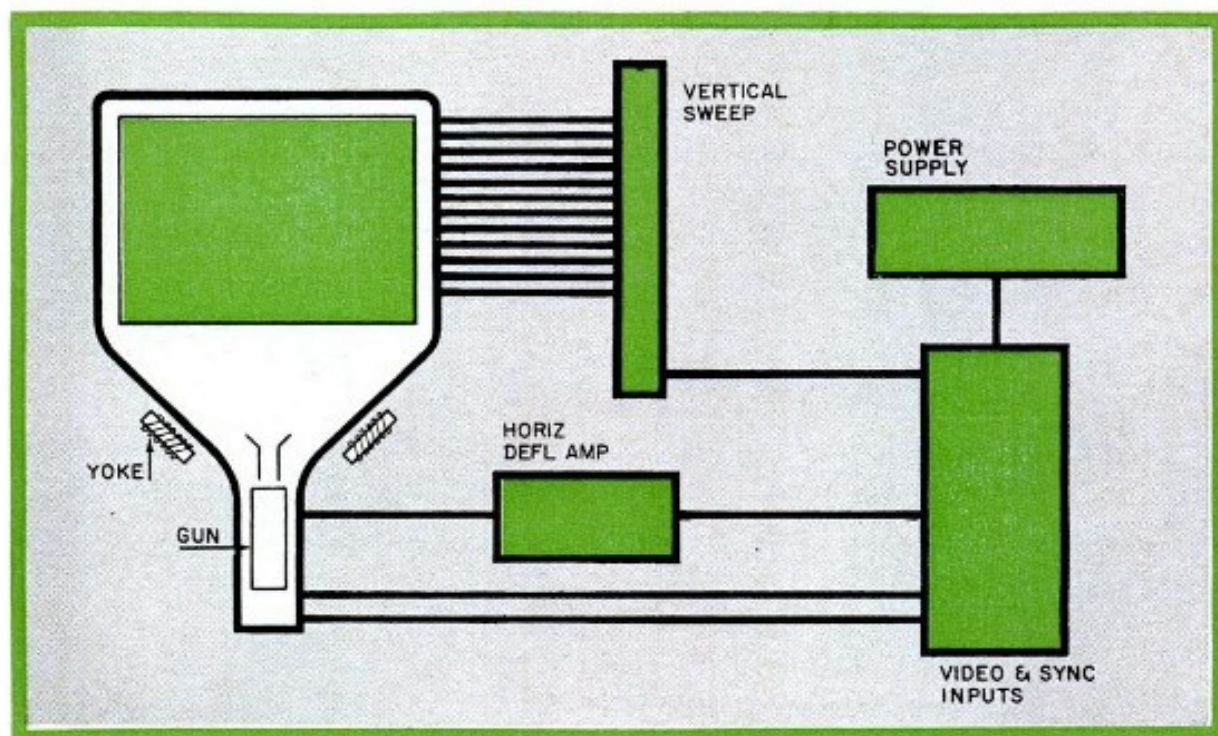
The Intertel sets are unique in several ways other than their use of the flat tube. To me, the most fascinating feature of all is that the picture can be viewed from either side of the tube. Of course, it appears in reverse on the back side, but it's a great way of making a small-screen portable viewable by a greater number of people.

Early models of the set will be viewable only from the front as the space behind the picture tube will be taken up by some electronic circuitry. Later versions may include the two-sided viewing if the public demands it. I think it will. The cabinet will be enlarged slightly to make room for the wiring that would otherwise block off the rear of the tube.

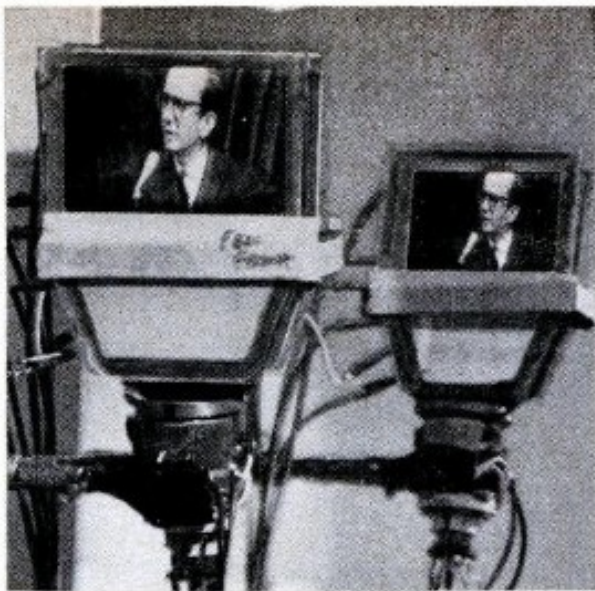
The color tube is unique in itself. It is a two-color tube that uses two electron guns and two phosphor screens instead of the three-gun system now accepted as the standard. It does this by combining the colors (red orange and blue green), following a specially developed additive system inside the tube, to give full color reproduction. Actually, at least to my eye, there are some discrepancies in the color reproduction. The two-color flat tube cannot deliver a true purple or a dark, intense blue. But flesh tones are more real than anything I've seen before and if these tones are right I doubt if you'll even know that the female singing star is wearing a purple dress and not the reddish-blue one you see.

Even more important is that the two-color tube gives a considerably brighter picture than the conventional color tube. This is vital to a portable TV that will be used outdoors every so often. The picture on a standard color set can barely stand up against normal room lighting. Outdoors it would be completely washed out and impossible to view.

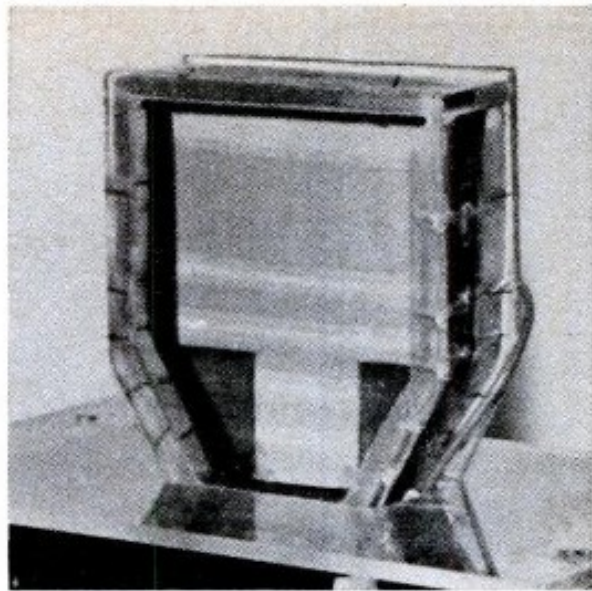
Since the flat tube is quite different from conventional picture tubes, it works a bit differently too. Look at the diagram at the top of page 91. You'll note that



SCANNING CIRCUITS ARE DIFFERENT. Block diagram shows the basic arrangement of horizontal and vertical sweep circuits required by the new flat tube. Each corner of the screen is perfectly square



MONOCHROME TUBE IN ACTION. Mirror behind tube lets you see image on the rear. It appears right side up as mirror inverts reverse picture



FLAT COLOR TUBE is two monochrome tubes back-to-back. Dual phosphor screen is in middle. Electron beams are directed to it from both faces



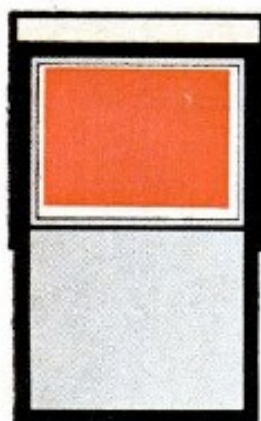
INVENTOR WITH HIS BRAINCHILD. Leo Shanafelt, top-notch engineer behind the flat tube, works at his laboratory bench where he has the monochrome tube set up for another round of experiments

there are two electron guns at the bottom of the tube: one for each of the two phosphor screens. These screens are deposited on opposite surfaces of a thin (.030-inch) sheet of glass.

This dual screen is firmly fastened in the exact center of the tube. The electron guns fire a beam of electrons straight up behind the screen from either side. The yoke around the neck of the tube deflects the beam from side to side. The transparent deflection stripes on each face of the tube, directed by signals from the set's deflection circuits, deflect the beams against their respective phosphors to produce a picture.

The monochrome tube is a bit simpler as it has only one electron gun and one set of deflection stripes. On the crude handmade tubes I watched, these stripes are just barely visible as slightly darker portions of the screen while a picture is being viewed. In production versions of the tube these stripes should be completely invisible.

The advantages of a flat tube are many and varied. Some are quite obvious;



some not quite so apparent. Here are the most important ones:

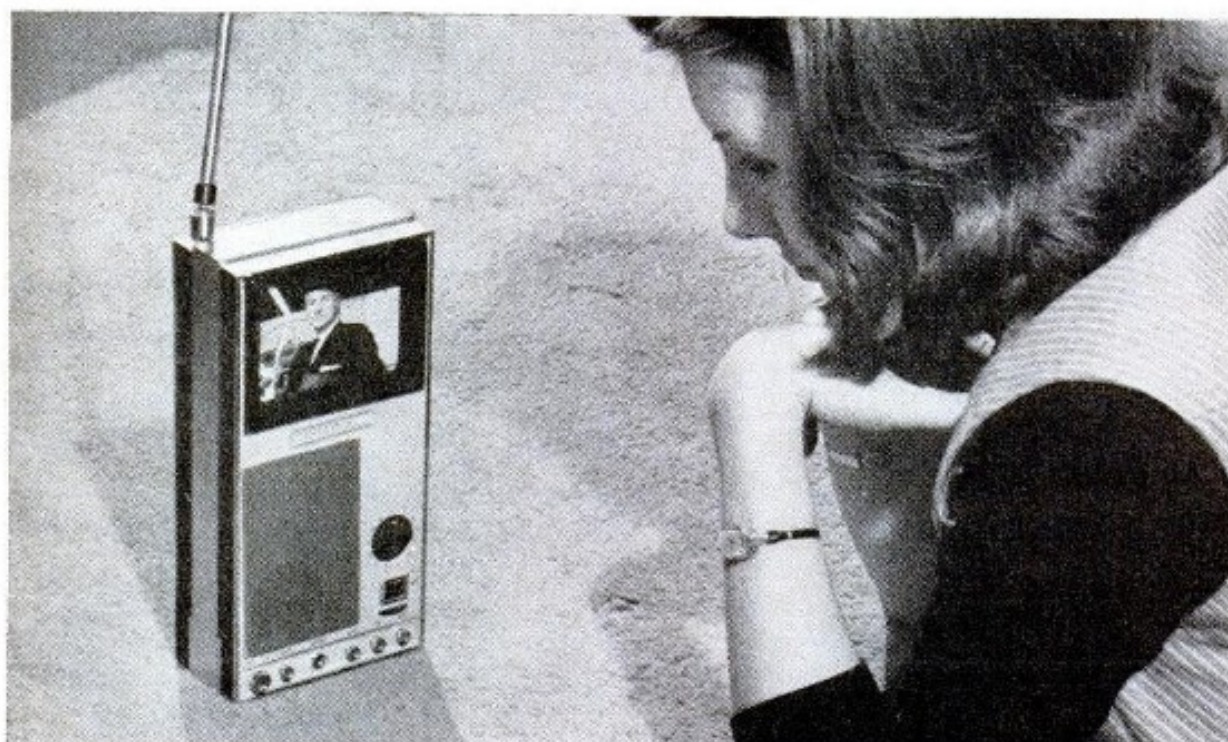
- Flat-tube sets are extremely thin, especially when compared to present-day models. They are easier to fit into a crowded room and do not take up floor space.
- Smaller, more compact TVs are possible. This means greater portability, lighter weight.
- Picture tubes are less complex. Specially blown glass envelopes are no longer needed. Ordinary plate-glass screens are easy to make.
- Two-sided viewing can be provided, if desired.
- Truly miniature, book and pocket-size sets become feasible. You may be looking for one soon.

Now let's look at a tiny flat-tube portable and see what we can do with it. Like a transistor radio, it can go anywhere. It's light and extremely portable. You can pass it to the kids to keep them occupied during long auto trips. You can take it with you to the beach or take it along on your winter ski tours. Or, for that special-occasion telecast you would give anything to see, bring it with you to your job—if you have an understanding boss.

In your home, large-screen sets will be built into the walls; they can be that thin. Those who like to watch TV in bed will be able to fit a set into the ceiling. Exotic styling for tabletop sets will become standard and remote controls for operating the set from your seat will be a must.

Other changes in set design resulting from the flat tube, as well as innovations in the tube itself, are bound to outreach my imagination. I'm sure that one day we'll have wall-sized screens made out of a flexible luminescent material that we can roll up out of sight when not in use. We may even end up with three-dimensional color TV.

But no matter which direction TV may take in the future, the industry is—right now—accomplishing a major breakthrough. The set manufacturers have been given a new ball to play with and I, for one, intend to keep tabs on what they do with it. ★★★



HER FIRST CLOSE-UP GLIMPSE of a flat TV portable in action utterly fascinates pretty PM secretary Millie Pedersen. Now, all she wants to know is how soon she can get one and how much it will cost

Driving Tips From the U.S. Air Force Test Page 61

POPULAR MECHANICS

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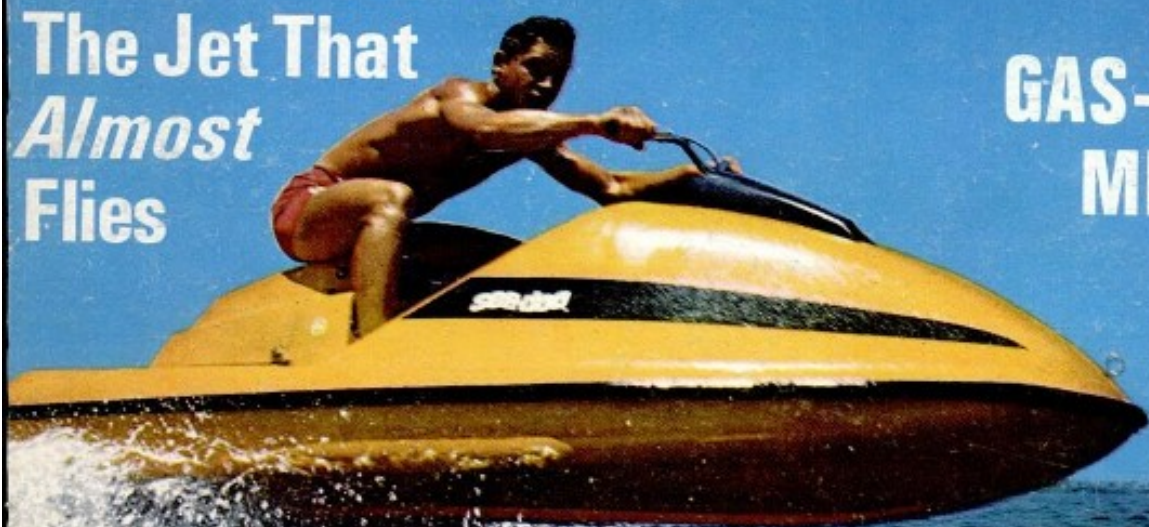
What
Owners
Think of
Torino
and Dart

Bombardier's New *SEA-DOO*

The Jet That
Almost
Flies

BUILD PM's
GAS-POWERED
MINI-TRUCK

Page 140



Please, Mr. Automaker:
Can't You Cure These Headaches?
(An Open Letter to Detroit)

The New All-Out War on Forest Fires

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Sea-Doo: A JET SPEEDSTER THAT BRINGS NEW ZOOM AND A NEW BOOM TO BOATING FUN

By **DAN FALES**, *Boating Editor*

Photos by Burton McNeely

HERE'S THE FIRST report on the newest and hottest "boat" you'll see this summer. Called Sea-Doo, it's to water what snowmobiles are to snow. In fact, this jet-powered water scooter is produced by Bombardier, Ltd., maker of the popular Ski-Doo snowmobiles.

During a special trip to Florida, I rode a new Sea-Doo. I raced it, jumped it, played tag with it, spun it out. I tried to tip it, to drown it, to foul it on a beach. Verdict: a fun machine that's bound to catch on.

But Sea-Doo's success will not be based on fun alone. There are two other important reasons. First, no propeller. Second, it won't tip over (unless you really **work** at flipping it). Until now, water scooters have been sexy little boats usually powered by outboard motors;

they're fast, but most have propellers extending below the hull. Generally, the props are shielded, but they still can present problems. Some people claim they are unsafe, others feel they draw too much water.

But Sea-Doo doesn't have a prop—it uses a water jet. And only three inches of water is needed when the machine's at rest—less when up on plane.

Bombardier, this summer, is testing its new scooter in several areas of North America. The company expects to swing into normal production next season.

The power behind each Sea-Doo is a 320-cc, 2-cycle Rotax motor that develops 18.5 hp. Through a system of four belts, this motor has direct drive to a Berkeley jet pump. Once on plane, the jet will push Sea-Doo at about 25 mph—depending on load.

Bombardier says its new scooter will handle a load of 250 pounds. But in fact, you don't want to put much more than 200 pounds aboard.

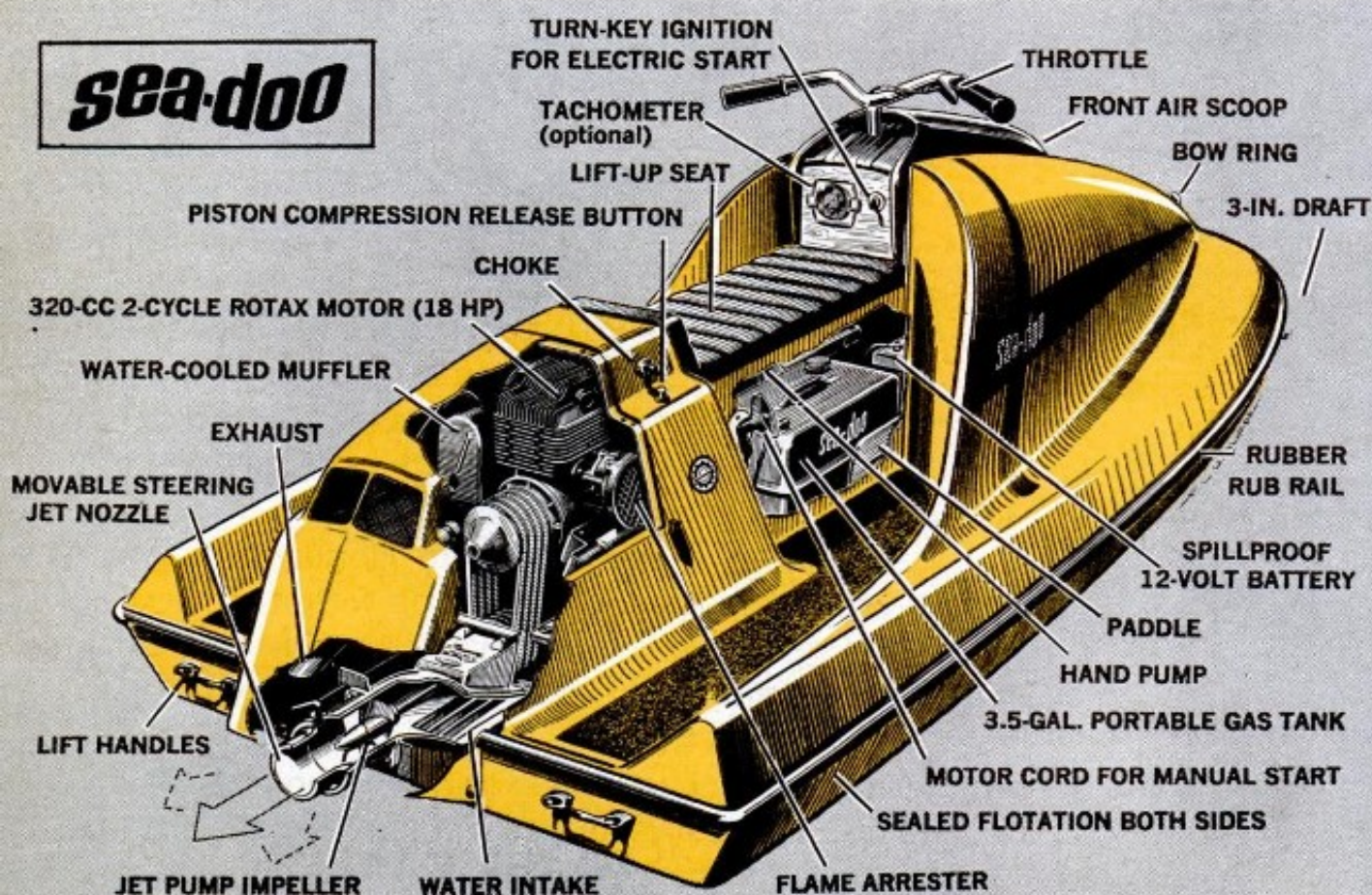
The lighter the weight, the quicker you'll get her up on plane. With my

weight pushing the 200-pound limit, I found I really had to lean forward to get Sea-Doo up on the step. Actually, I had to try to push the bow down with my left hand as I kept the motor wide open with my right grabbing the handlebar throttle.

But once on plane, I flew. I found myself riding Sea-Doo like a snowmobile. I stood up and jockeyed back and forth—hiking my weight out on every turn. I was surprised though at the stability of this machine. Sea-Doo is almost elliptical in shape. It's 7½ feet long and 5 feet wide. No matter what I did under way, I always felt I had complete control, and never did I feel that she would break away and spill me.

I even tried standing with both feet on one side while going 25 mph. Even in a turn Sea-Doo was stable.

Next came the spin-out test. Again doing 25 mph, I raced down a long straightaway. When I thought she was at top speed, I spun the handlebar. The jet swung her stern around. I hung on while doing a 360° spin. After the spin, I was almost dead in the water. The





JUMPING OFF a ramp built at the end of a dock can be loads of fun. Note that use of a water-jet pump eliminates any need for a propeller that hangs below the hull. Except for several stabilizing skegs, the bottom is smooth. Fiberglass hull easily takes pounding when you land

ZIPPING ALONG on relatively calm water makes for easy maneuvering, as you can see from look-ma-no-hands operation. Bombardier says the machine functions well in anything up to a two-foot chop. For saltwater operations, all motor surfaces are treated to resist corrosion

STABILITY is an asset in this machine. Though you might think it's about to tip over—it never did, even with the driver hiked way out to one side. He could have flipped it at this point if he wanted by giving an extra yank on the handlebar. But this would take a deliberate effort

